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GEOLOGICAL SURVEY OF ALABAMA

EUGENE ALLEN SMITH, *State Geologist*

BULLETIN No. 27

STATISTICS OF THE MINERAL PRODUCTION OF ALABAMA FOR 1922

COMPILED FROM THE MINERAL RESOURCES OF THE UNITED STATES

By
WALTER S. ERNST

UNIVERSITY OF ALABAMA
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LETTER OF TRANSMITTAL

University, Ala., May, 1924.

Hon. William W. Brandon,

Governor of Alabama,

Montgomery, Ala.

SIR:—I have the honor to transmit herewith the manuscript of a report on the Mineral Production of Alabama for the year 1922, with the request that it be printed as Bulletin No. 27 of the Geological Survey of Alabama.

Very respectfully,

EUGENE A. SMITH,
State Geologist.

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A. L. Stow .... Alexander City, Ala.

Elk River at Elkmont, Alabama

W. E. Maples .... Elkmont, Alabama

PREFACE

THE statistics of all the mines included in the following pages have been collected in co-operation with the United States Geological Survey, and have been compiled from advance chapters of the *Mineral Resources of the United States*, a publication of the Federal Survey and Census.

The introductory and general matter in each of these articles has either been taken without change from the U. S. advance chapters or has been rearranged or condensed from these chapters, or entirely rewritten to suit it to our present purposes. In each case credit is given to the author.

TABLE OF CONTENTS

	Page
Introduction	7
Abrasives	12
Millstone Producers	12
Barytes	13
Barytes Producers	14
Bauxite and Aluminum	15
Bauxite	15
Market and Prices	16
Occurrence and Character of Bauxite in the U. S.	18
Bauxite Deposits	19
Aluminum	21
Domestic Production and Consumption	21
Market and Prices	22
Aluminum Industry	23
Aluminum Salts	23
Aluminum Salts Industry	24
Tariff	26
Aluminous Refractories	26
Bauxite Abrasives	27
Bauxite Producers	27
Cement	28
Portlnad Cement	28
Puzzolan Cement	29
Recovery of Potash from Portland Cement Materials	31
Cement Producers	31
Clay	32
Raw Clay Producers	33
Clay and Refractory Products	34
Brick and Tile Producers	38
Pottery Producers	39
Coal	40
Introductory	40
Production	41
Labor Statistics	46
Mining Methods	47
Coal-Washing Operations	47
Coal Producers	48
Coke	51
Introduction	54
Coke in Alabama	54
Production and Consumption	54
Beehive Coke Producers	59
By-product Coek Producers	59
Fullers Earth	60
Imports	60
Fullers Earth Producers	61
Graphite	62
Introduction	62
Uses of Graphite	62
Production	64
Graphite Producers	67
Natural Graphite	67
Manufactured Graphite	69
Imports and Exports	69
Prices	71
Review of World's Graphite Industry	72

	Page
Iron Ore, Pig Iron and Steel	75
General Review	75
Southern States	77
Sources of Iron	78
Iron Ore	79
Hematite	79
Brown Ore	81
Magnetite	83
Siderite	84
Impurities in Iron Ore	84
Range in Composition	85
Beneficiated Iron Ore	87
Details of Iron Ore Production	89
Iron Ore Mines	90
Iron Ore Producers	91
Pig Iron	93
Shipment, Value and Production	93
Average Prices	95
Commercial Quotations	97
Daily Average Production	97
Production by Grades and by Fuel Used	98
Total Domestic Production	98
Blast Furnaces	99
Foreign Trade in Pig Iron	100
Ferroalloys	101
Shipments Value and Price	101
Steel	103
Production	103
Lime	106
Hydrated Lime	107
Kilns	108
Lime Producers	109
Mica	110
Introduction	110
Nature and Occurrence	110
Production	112
Mining	115
Classification of Mica	116
Uses	118
Mica Producers	120
Mineral Waters	121
Scope of Report	121
Output and Value	122
Soft Drinks	123
Condition of Trade	125
Mineral Water Trade in Alabama	125
Mineral Water Producers	127
Sand and Gravel	128
Sand and Gravel Producers	130
Stone	131
Production	131
Limestone	131
Limestone for Building Purposes	132
Limestone Producers	135
Marble	135
Marble Producers	136
Sandstone	137
Sandstone Producers	137
Summary	138

INTRODUCTION

THE outstanding feature of the mineral industry for the State in the year 1922 was the recovery from the protracted slump that it had undergone during the depression of business in 1921. Improvement in some branches of the industry had begun late in 1921 and became more general in the early months of 1921. The complete shut down of union collieries due to the miners strike in coal fields outside of the State added greater stimulus to the improvement in conditions in the local coal fields, considerable tonnage finding ready markets outside of the State. The full advantage of this position was not realized due to the effect of the strike of the railway shopmen, in July. Uncertain and interrupted transportation reacted to force a curtailment of production in all industry. Improvement in the transportation situation, though gradual, could be seen toward the end of the year and the final results on the mineral production of the State for the year shows a marked activity toward capacity production on a peace time basis.

An inspection of the subjoined tables will show the individual improvement of the various industries of the State. Compared to the year 1921 the improvement is marked for the majority of producers, because in most cases the output of mineral resources had been curtailed. One exception to this condition is the Portland Cement industry. It enjoyed increased business during the period of general depression and added to the production of 1922 a considerable quantity of stored production. This had the effect of further improving the growth of the industry, which showed an increase in shipments of 35.6 per cent over 1921. Reduction of stocks on hand and prospects of greater business have called attention to the fact that Alabama has excellent opportunities for the growth of this industry. Several large plants are contemplated for the Birmingham district and when erected will more than double the present output of this product.

Following the plan set out by Mr. E. W. Parker in 1913 and followed by the Alabama Geological Survey, we pass in

review the mineral production of Alabama in 1922, and the immediate derived products of the minerals, taking them somewhat in the order of their importance:

Coal.—The production of coal in Alabama in 1922 was 18,324,740 short tons, valued at $42,856,000, an increase in quantity of 45 per cent and in value of 10 per cent. The coal products constitute a large per cent of the mineral products of the state.

The principal coal producing counties are Jefferson, Walker, Tuscaloosa, Bibb, St. Clair, Shelby, and Etowah, in the order named.

Coke.—The production of coke in the State showed a decided improvement for the year over that of 1921. The production was 3,799,865 short tons valued at $14,708,245, as compared with 2,534,039 short tons valued at $12,256,085, an increase in quantity of 50 per cent and in value of 10 per cent.

Iron Ore.—In 1922 the production of iron ore was 5,294,520 long tons, valued at $8,791,069, as compared with 2,835,761 long tons valued at $5,058,161 in 1921, an increase in quantity of 87 per cent and in value of 74 per cent.

Alabama produced 11 per cent of the total production of iron ore in the United States. The most important ore of the state is hematite, some brown ore is produced.

The principal iron ore producing counties are Jefferson, Tuscaloosa, Franklin and Etowah.

Pig Iron.—The production of pig iron in the State for the year 1922 showed the results of the revival of business. The quantity of pig iron produced was 2,223,159 gross tons, valued at $42,883,424 as compared with 1,210,596 gross tons, valued at $28,482,713, an increase in tonnage of 79 per cent and in value of 42 per cent over the year of 1921.

Clay Working Industries.—These industries yielded in 1922 products valued at $2,798,255 as compared with $2,266,704 in 1921, an increase of $531,551 or 23.5 per cent. This does not include 60,523 tons of raw clay valued at $49,765. Production of raw clay increased 29.1 per cent over that of 1921.

Common and vitrified brick, fire brick, face brick, hollow building tile and drain tile were the principal products of the State.

The center of the clay working industry is in Jefferson County, and Birmingham furnished the principal market for the products.

The pottery produced in 1922 consisted of stone-ware, yellow and Rockingham ware, and red earthen ware, including turpentine cups, and represented a value of $26,100.

Stone.—The year 1922 still shows the effect of the business depression of 1921, the value of the stone produced showing but a slight increase. The value of the output in 1922 was $1,343,998 as compared with $1,304,965 in 1921, an increase of $39,033.

Limestone is by far the most important stone produced in the State. As in previous years the most extensive use of limestone was for furnace flux. Next in importance is the use of limestone for road making, though the amount used does not compare with that used for flux.

Beautiful white marble occuring in Coosa and Talladega Counties, is extensively used for building purposes, (both inside and outside work). A black marble which gives promise of future development has been prospected near Piedmont and near Anniston.

The reader is referred to the body of this bulletin, under Stone, for further details concerning especially the building stone and marble industries.

Cement.—The cement industry of the State has shown a healthy, steady growth that was not checked to an appreciable extent by the business depression of 1921. The State is well endowed with the necessary raw material and abundant fuel supplies in close proximity. The steady demand for Portland cement combined with the natural resources is rapidly putting the State in a similar position in the cement industry as it now holds for iron production.

The industry produced 2,324,116 barrels of cement valued at $4,135,684 during the year of 1922 as compared to 1,714,-286 barrels valued at $3,466,223, an increase in production of 35.6 per cent and in value of 19.2 per cent.

The annual capacity was 2,413,000 barrels for 1922. It is evident then that the industry operated at 96.3 per cent of capacity. Stocks on hand showed a decrease of 48.4 per cent over the preceding year.

Lime.—The production of lime is taken separately from that of limestone.

Since the beginning of extensive production of lime in 1919, Alabama has remained among the leading lime producing States, ranking sixth in 1922.

Alabama was not slow to respond to the firm tone of the market and 1922 shows an increased output with one more producer than in 1921. The total product from the eleven plants in 1922 was 168,135 tons valued at $979,331 as compared with 109,256 tons valued at $847,629 in 1921, an increase in production of 53 per cent and in value of 15.5 per cent.

Graphite.—The graphite produced in Alabama is of the crystalline variety. Little activity in graphite production has been noted since the shut down forced by the economic conditions of the market following the close of the war. Several companies have resumed operations but the production as yet is not very large.

Minor Products.—There are produced in Alabama small quantities of the following: Barytes, bauxite, millstones, mineral waters, sand and gravel, manganese and Fullers earth.

In the following table there is a comparison of the raw products produced in Alabama for the years of 1921 and 1922 together with a comparison of the derived products for the same period. The sum of the value of the raw products and of derived products will be considered the total value of the mineral production of the State.

Mineral Production in Alabama, 1921 *and* 1922

PRODUCT	1921				1922			
	Raw		Derived		Raw		Derived	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Coal, short tons	12,568,899	$38.713,000			18,324,740	$42,856,000		
Coke, short tons			2,534,039	$12,256,085			3,799,865	$14,708,245
Iron Ore, long tons	2,835,761	5,058,161			5,294,520	8,791,069		
Pig Iron, long tons			1,210,596	28,482,713			2,223,159	42,883,424
Limestone, exc. of marble		737,513				787,040		
Cement, barrels			1,714,286	3,466,223			2,324,116	4,135,684
Lime, short tons			109,256	847,629			168,135	979,331
Marble		530,711			†	*		
Clay Products				2,536,078				2,798,255
Graphite, pounds	†	*			†	*		
Sand and Gravel, short tons	774,616	381,425			848,743	346,920		
Clay, short tons	46,852	48,736			60,523	49,765		
Bauxite, long tons	†	*			†	*		
Sandstone, including ganister	22,200	36,741				41,395		
Barytes, long tons	†	*			†	*		
Mineral Waters, gal. sold	892	690			5,389	875		
Mica, sheet, pounds					†	*		
Mica, scrap, short tons					†	*		
Manganese Ore, long tons	†	*			†	*		
Miscellaneous		106,903				702,533		
Total		$45,613,880		$47,739,564		$53,575,597		$65,504,939

*Included in Miscellaneous. †Less than three producers; survey not at liberty to publish figures.

STATISTICS OF THE MINERAL PRODUCTION OF ALABAMA FOR 1921

ABRASIVES.

EUGENE A. SMITH

ALABAMA'S production of abrasives is at present limited to a small number of millstones (chasers*) of Pennsylvanian age, quarried and made at Dutton, Jackson County; there are, however, several materials in different parts of the State which are sufficiently promising to be worth investigating and thorough testing; the nature and locality of these deposits were treated in Bulletin No. 13, which see.

There was a small amount of abrasives produced in Alabama in 1922.

MILLSTONE PRODUCERS IN 1922

M. Morris, R. D. 1, Dutton, Ala.; quarry in Jackson County.

*Chasers are larger than the regular millstones. They are used for heavier work, such as grinding quartz, feldspar, barytes, etc., and they run on edge. Though they are made with a diameter as short as 24 inches, they are usually turned out with diameters ranging from 50 to 84 inches, and are as much as 22 inches in thickness. These chasers are run on pans paved with roughly cubical blocks of the conglomerate, with edges about a foot in length. In grinding quartz in such pans the chasers are used in the preliminary crushing; then rough blocks, usually three in number, are either attached to or carried along by lateral arms, which in turn are joined to a vertical revolving shaft. By the circular movement of these blocks the material placed in the pan is ground to powder.

BARYTES

By G. W. Stose

Barytes was produced by two companies during the year of 1922. The output showed a substantial increase over that of 1921. Shipments were more than doubled during the year with a carry over of a small stock.

From one to three miles north of Angel Station and about twelve miles northwest of Jacksonville, Calhoun county, there are a series of barytes deposits on which a little development has been done. These deposits lie at the base of a white quartzite ridge in residual clay that is derived from blue-gray magnesian limestone, whose age has not been definitely determined but which is probably Knox dolomite.

Other deposits near Vincent, Harpersville and Wilsonville, Shelby County, and Leeds, Jefferson County, were under development in 1918. The barytes was mined from red residual clay overlying limestone of Beekmantown age.[1] High grade barytes has been produced from these developments and indications at a number of places point to larger bodies than the irregular masses first found.

Details concerning the manufacture of ground barytes, of lithopone, and of barium chemicals and their uses are given in Bulletin No. 19 of the Alabama Geological Survey, and in the Mineral Resources of the United States for 1916.

The Bertha Mineral Company increased shipments from its mine at Angel, Calhoun County, during the year. The Alabama Barytes Co. (Inc.), a new concern, began operating a deposit near Harpersville, Shelby County, Alabama, in November, 1922 and shipped some ore.

1. Butts, Charles, U. S. Geol. Survey Geol. Atlas, Montevallo-Columbiana folio (in preparation).

Crude barytes produced and sold in the United States, 1920-1922, by States

State	1920			1921			1922		
	Short tons	Value*		Short tons	Value*		Short tons	Value*	
		Total	Average.		Total	Average.		Total	Average.
California	2,250	$20,850	$9.27	942	$5,084	$5.40	3,338	$17,707	$5.30
Georgia	84,644	790,362	9.34	24,614	191,442	7.78	57,045	468,517	8.21
Missouri	99,654	1,013,570	10.17	25,200	217,913	8.65	66,421	421,568	6.35
Tennessee	29,319	213,657	7.29	8,180	61,148	7.48	16,642	124,204	7.46
Other States†	12,246	104,025	8.49	7,433	56,371	7.58	11,594	91,954	7.93
Total	228,113	2,142,464	9.39	66,369	531,958	8.02	155,040	1,123,950	7.25

*Value f. o. b. mine shipping point.

†States having less than 3 producers each are grouped together to avoid disclosing confidential information. 1920: Alabama, Illinois, Kentucky, Nevada, North Carolina, South Carolina, Virginia, and Wisconsin; 1921: Alabama, Illinois, North Carolina, South Carolina, and Virginia; 1922: Alabama, Idaho, Illinois, North Carolina, and South Carolina.

BARYTES PRODUCERS IN 1922

Alabama Barytes Co., (Inc.) mine at Harpersville, Shelby County.
Bertha Mineral Co., mine at Angel, Calhoun County.

BAUXITE AND ALUMINUM

By James M. Hill

Bauxite

Domestic Production

THE bauxite industry of the United States showed marked improvement in 1922 over the conditions during 1921, owing to the increased demand for the products made from bauxite, particularly aluminum and aluminous abrasives. The domestic production of bauxite increased 122 per cent, as compared with 1921.

The production of bauxite in Georgia, Alabama, and Tennessee increased from 14,700 long tons in 1921 to 42,810 long tons, and in value from $134,400 to $329,440, an increase in quantity of 191 per cent, and in value of 145 per cent.

In 1922 about 68 per cent of the bauxite was used in the aluminum industry, with chemical uses coming second.

The figures for imports and exports in the following table have been compiled by J. A. Dorsey, of the United States Geological Survey, from records of the Bureau of Foreign and Domestic Commerce. The apparent consumption in the United States, as given in this table, is greater than the actual consumption, for the bauxite concentrates exported represent several times as much crude bauxite. Data from which to compute this difference are not available, but it is probably not very great.

Bauxite produced and consumed in the United States, 1918-1922

YEAR.	DOMESTIC PRODUCTION					
	Georgia, Alabama, and Tennessee		Arkansas.		Total	
	Quantity (long tons)	Value	Quantity (long tons)	Value*	Quantity (long tons)	Value*
1918	42,829	314,112	562,892	3,133,880	605,721	3,447,992
1919	43,076	346,588	333,490	1,855,159	376,566	2,201,747
1920	40,029	349,453	481,279	2,897,892	521,308	3,247,345
1921	14,700	134,400	124,850	755,400	139,550	889,800
1922	42,810	329,440	266,790	1,682,890	309,600	2,012,330

YEAR	Imports		Exports†		Apparent domestic consumption	
	Quantity (long tons)	Value	Quantity (long tons)	Value	Quantity (long tons)	Value
1918	3,653	14,791	19,711	1,523,688	589,663	1,939,095
1919	6,082	36,820	17,701	1,372,094	364,947	866,473
1920	42,895	251,284	22,257	1,843,596	541,946	1,655,033
1921	27,587	164,589	5,942	488,785	161,195	565,604
1922	23,656	93,805	19,617	961,208	313,639	1,144,927

*Value f. o. b. mines.
†Includes bauxite concentrates.

In addition to the bauxite sold to various consumers, there was also sold to some of them in 1922 about 40,000 tons of diaspore clay, valued at approximately $3 a ton. Only a small portion of this high-alumina clay is used in the chemical industry, but about 90 per cent is used in the manufacture of alumina refractories.

A small quantity of alumina obtained as a by-product in the treatment of alunite for its potash content at Marysvale, Utah, was used for refractories.

Domestic bauxite was reported as sold to four consuming industries in 1922, as shown in the following table. The consumption increased 131 per cent in the aluminum industry, 92 per cent in the aluminum chemical industry, and 181 per cent in the artificial abrasive industry. The last figure is of particular interest in that the consumption of abrasives follows the trend of the metal manufacturing and fabricating industries of the country.

Domestic bauxite consumed by various industries, 1918-1922, *in long tons*

Industry	1918	1919	1920	1921	1922
Aluminum	419,043	272,270	383,154	91,700	211,560
Chemical	63,896	67,842	85,878	41,000	78,540
Abrasive	112,908	35,395	*52,276	6,850	19,270
Refractory	9,874	1,059	....	....	230

*Probably includes a small quantity sold to makers of refractories.

MARKET AND PRICES

Bauxite finds its market east of the Mississippi River and is sold largely to the manufacturers of aluminum, commercial chemicals, abrasives, and refractories. In the last few years

some of the makers of refractories and aluminum chemicals have been using clay as a crude material, presumably mixed with bauxite in varying proportions. The clays used in place of bauxite are what might be termed "high-aluminum clays," in that they carry larger quantities of aluminum oxide than kaolin. Most of such clays come from central Missouri, where diaspore-bearing clays carrying over 50 per cent of alumina are known to occur. These clays are now being marketed according to their alumina content, and three grades containing 55, 65, and 70 per cent of alumina (Al_2O_3) are regularly handled.

The largest consumers of bauxite in the United States are also producers, and there is only a small market for what might be called "outside bauxite." Consumers who do not own deposits contract for their supplies for considerable periods, apparently with the idea of assuring themselves of an adequate supply of bauxite of the grade desired. The price of bauxite at mines or shipping points in 1922 as reported by independent producers, ranged from $7.50 to $10 a ton; the average price reported by all producers for the year was $6.50 a ton f. o. b. mines. Consumers, on the other hand, report prices that average $14 a ton f. o. b. plants, a reduction of $1 a ton as compared with costs in 1921.

Bauxite is now regularly quoted in the Engineering and Mining Journal-Press. Crude bauxite was quoted at $8 to $10 a long ton during January and February and at $6 to $9 during the rest of the year. Dried and pulverized bauxite was quoted at $12 to $14 and calcined at $22 to $25 a ton f. o. b. shipping point. Foreign bauxite was offered at $5 to $8 c. i. f. American ports.

Under the tariff act of 1922 crude bauxite is dutiable at the rate of $1 a ton and alumina hydrate or refined bauxite at 1 cent a pound. (See par. 6 schedule 1, and par. 207, schedule 2.) Under the tariff of 1913 there was no import duty on bauxite, and the rate on alumina was 15 per cent ad valorem.

For a complete list of the consumers and producers of bauxite in the United States refer to Bulletin 25 of the Alabama Geological Survey.

OCCURRENCE AND CHARACTER OF BAUXITE IN THE UNITED STATES

The known commercial bauxite deposits of the United States are in Calhoun, Cherokee, and DeKalb counties, Alabama; Pulaski and Saline counties, Arkansas; Bartow, Floyd, Meriwether, Sumter, and Wilkinson counties, Georgia; and Carter and Hamilton counties, Tennessee. A brief description of the geology of the domestic deposits was given in the report for 1916* and detailed descriptions of the deposits in Central Georgia have been published by the Georgia Geological Survey.†

The bauxite from all localities in the United States, though it may vary in chemical composition, is on the whole similar in general appearance, with the exception of the "granitic bauxite" of the Arkansas field. The greater part of the American bauxite appears to be made up of rounded pebble-like bodies set in a fine-grained matrix, which may also consist of small rounded particles or may be as fine grained as the finest clay. The pebble or pisolite form is so general that it is the conspicuous characteristic of American bauxite.

There is only one way to determine the value of bauxite, and that is by chemical analysis, which should show total silica, alumina, titanium oxide, iron oxide, and water. Bauxite of commercial grade should carry at least 52 per cent of alumina.

A few characteristics that indicate in a general way the quality of bauxite may be mentioned, though none of them are to be depended on. In general, bauxite of fair grade will not show the marks of a hammer when it is hit a glancing blow, though some bauxite has been shipped which can be cut with the hammer. Good bauxite that has been dried either in the open or in kilns when thrown on a hard floor has a distinct rattle, which bauxitic clay does not have. The pisolites of a lighter-colored bauxites of the Central Georgia field have a peculiar brownish-buff color and look something like horn or flint; they ordinarily can not be broken or marked with the finger nail in bauxites of good grade.

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*Hill, J. M., Bauxite and aluminum in 1916; U. S. Geol. Survey Mineral Resources, 1916, pt 1, pp. 161-165, 1917.

†Shearer, H. K., A report on the bauxite and fuller's earth of the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 31, 1917.

Some measure of the relative quality of dried bauxite can be had by grinding a sample in an agate mortar for half a minute. A bauxite of good grade will be found hard to grind and will stick to the mortar with such tenacity that it will have to be scoured out; a poor bauxite or bauxitic clay will grind much more easily and will stick very little, if at all; and clay or kaolin grinds with ease and does not stick to the mortar. Similar results are found if the sample is rubbed on glass; the glass will not be scratched by even high-grade bauxite.

BAUXITE DEPOSITS

A general account of the bauxite deposits in the United States, specifications for bauxite, and much information concerning the industry has been given in a recent paper by Ladoo.*

Users of aluminous ores should be informed that diaspore in fairly pure crystalline form is found in some places in sufficient quantities to be of commercial interest. It is believed that this material could be used for abrasives and refractories and could probably also be treated for the manufacture of aluminum chemicals. Kyanite, sillimanite, and andalusite, aluminum silicates carrying more than 60 per cent of alumina, could possibly also be used for some of the purposes to which bauxite and diasporite clays are now being put. Kyanite is possibly the most readily available, and large deposits of it have been reported from Wyoming and Arizona.

Alabama.—The Republic Mining & Manufacturing Co. continued operations at Rock Run, Ala., in 1922, and was the only bauxite producer in the State. The E. I. du Pont de Nemours Co. has permanently abandoned the mining of bauxite in Alabama and elsewhere and in the future will purchase bauxite needed for its works at Philadelphia.

Arkansas.—At Bauxite, Saline County, Ark., the American Bauxite Co. increased its operations considerably, as compared with 1921, but did not attain its maximum production. The Southern Bauxite Co. opened a bauxite deposit adjoining the American Bauxite Co.'s property and made some ship-

*Ladoo, R. B., Bauxite—occurrence, mining, and uses: Eng. and Min. Jour.-Press, vol. 114, pp. 805-808, 1922.

ments. In Pulaski County the Republic Mining & Manufacturing Co. and Globe Bauxite Co. continued operations. All the bauxite produced in Arkansas was dried before shipment, and most of it was used for the manufacture of aluminum. The Arkansas Legislature in 1923 passed a law that imposes a tax of 25 cents a long ton on all bauxite mined in the State.

Georgia.—Bauxite was produced in six counties in Georgia during 1922. Mines in Sumter County produced the greatest amount, followed in order of production by Macon, Floyd, Wilkinson, and Bartow. About 85 per cent of the bauxite mined in Georgia was sold dried and 15 per cent crude; practically 95 per cent went to makers of aluminum chemicals. The largest producer of bauxite in the State was the Republic Mining & Manufacturing Co., the Kalbfleisch Corporation was second, the Ideal Bauxite Co. and Hebble Estate were about equal for third place, and the Warner Bauxite Co. was fourth. It is reported that the Republic Mining & Manufacturing Co. has discontinued operations at the Sweetwater mine, near Andersonville, owing to the cost of removing the heavy overburden of sand from the bauxite bed.

It is understood that a detailed study of the clay and bauxite deposits tributary to the Central of Georgia Railway was made by T. Poole Maynard, geologist of the company, in cooperation with the United States Bureau of Mines. The results of this investigation are to be made public in a series of papers to be published in the Journal of the American Ceramic Society.

Recent reports that the Ford interests have purchased several bauxite deposits in Georgia are not correct.†

Mississippi.—So far no bauxite has been shipped from the deposits in Tippah, Benton, Union, and Pontotoc counties, Mississippi. It is said that the best deposits are in Pontotoc County. The Mississippi Bauxite Co. estimates that it controls a considerable quantity of merchantable ore.

Missouri.—The diaspore deposits of Gasconade and Maries counties, of central Missouri, continue to supply a clay sufficiently high in alumina to compete with bauxite for the manufacture of aluminous refractories and, to some extent, for the manufacture of aluminum salts and abrasives. The principal producers are the American Refractories Co., Evens

†Letter from Henry Ford.

& Howard Fire Brick Co., H. H. Heck Clay Co., and Laclede-Christy Clay Products Co.

Howe and Ferguson* have recently published the results of some research work on the use of diaspore for refractories, and Wysor† has given a description of the high-alumina clay deposits of this region.

Tennessee.—The Kalbfleisch Corporation and White, McAllister & Keiser operated bauxite mines on Missionary Ridge near Chattanooga, Tenn.

Utah.—It seems probable that the alumina by-product from the potash plants in the vicinity of Marysvale, Utah, may soon compete with bauxite for both chemical and refractory use. An article by Tingley‡ describes the experiments carried on by the Mineral Products Co. and the Florence Mining & Manufacturing Co. with alunite from their extensive holdings in the Tushar Mountains. It is known that some of the alumina by-product made by the former company is now being used as a refractory. Alunite deposits are known to occur in various parts of the United States and may in the future be the basis of industries in areas where bauxite would not be readily obtainable.

ALUMINUM

DOMESTIC PRODUCTION AND CONSUMPTION

The value of new aluminum produced in the United States in 1922 was approximately 25 per cent greater than in 1921 but only a quarter as great as the peak value in 1917. The value of secondary aluminum produced in 1922 increased 61 per cent over the value in 1921. Imports were valued at about $800,000 more in 1922, and exports were about $270,000 less. The value of aluminum apparently consumed in the United States in 1922 was 30 per cent greater than that in 1921 and reflects the general business revival, particularly the revival of the automobile industry and the resumption of use of aluminum in the transmission of electrical energy.

*Howe, R. M., and Ferguson, R. F., Composition and properties of diaspore, bauxite, and gibbsite: Am. Ceramic Soc. Jour., vol. 6, p. 496, March, 1923 (abstract of article in Chem. and Met. Eng., vol. 28, p. 603, 1923).

†Wysor, D. C., Diaspore clay of Arkansas and Missouri: Am. Ceramic Soc. Jour., vol. 6, p. 501, March, 1923.

‡Tingley, R. H., Alunite and its products: Eng. and Min. Jour.-Press, vol. 115, p. 494, 1923.

Secondary aluminum was recovered in 1922, according to statistics collected by J. P. Dunlop, of the United States Geological Survey, to the amount of 7,190 short tons as metal and 9,100 short tons as the aluminum content of various casting alloys. The total recovery was 16,290 short tons.

Value of aluminum produced and consumed in the United States. 1918-1922.

YEAR	Domestic production*		Imports†	Exports‡	Apparent consumption
	Primary metal	Secondary metal			
1918	41,159,000	10,113,600	554,586	10,869,388	40,957,800
1919	38,558,000	12,014,600	4,568,595	3,890,326	51,250,900
1920	41,375,000	9,489,100	13,077,022	5,630,781	58,310,300
1921	10,906,000	3,775,400	8,889,791	3,108,857	20,462,300
1922	13,622,000	6,085,900	9,695,012	2,836,116	26,566,800

*Value of primary metal based on average open-market price at New York for small lots, as quoted by the Engineering and Mining Journal-Press, and that of secondary aluminum based on average price at New York as given by American Metal Market.

†Imports for consumption include aluminum in crude form, scrap, bars, strips, rods, plates, sheets, and all manufactures of.

‡Exports include ingots, metal and alloy, plates and sheets, and all other manufactures of.

MARKET AND PRICES

Quotations on virgin aluminum, as given by the Engineering and Mining Journal-Press during 1922, were steady at 20 cents a pound for the 99 per cent grade, 19 cents for the 98 per cent grade, and 18 cents for the 94-98 per cent grade until August, when an advance of 0.1 cent a pound was recorded for the two higher grades. In November the quotations were raised to 21 cents and they have continued to advance since then. Foreign aluminum was quoted at 2 or 3 cents less than domestic new aluminum, and secondary aluminum was sold at approximately the same price, the average for the year being 18.68 cents a pound.

In the tariff act of 1922 the following paragraphs, quoted from schedule 3, metals and manufactures, are of interest to all producers and consumers of aluminum:

Par. 339. Table, household, kitchen, and hospital utensils, and hollow or flat ware, not specially provided for; composed of iron or steel and enameled or glazed with vitreous glasses, 5 cents per pound and 30 per centum ad valorem; composed wholly or in chief value of aluminum, 11 cents per pound and 55 per centum ad valorem; composed wholly or

in chief value of copper, brass, or other base metal, not specially provided for 40 per centum ad valorem; in addition thereto, upon any of the foregoing articles containing electrical heating elements as constituent parts thereof, 10 per centum ad valorem.

Par. 374. Aluminum, aluminum scrap, and alloys of any kind in which aluminum is the component material of chief value, in crude form, 5 cents per pound; in coils, plates, sheets, bars, rods, circles, disks, blanks, strips, rectangles, and squares, 9 cents per pound.

Par. 382. Aluminum or tin foil less than six one-thousandths of an inch in thickness, 35 per centum ad valorem; bronze powder, 14 cents per pound; aluminum powder, powdered foil, powdered tin brocades, flitters, and metallics, manufactured in whole or in part, 12 cents per pound; bronze, or Dutch metal, or aluminum in leaf, 6 cents per hundred leaves. The foregoing rate applies to leaf not exceeding in size the equivalent of five and one-half by five and one-half inches; additional duties in the same proportion shall be assessed on leaf exceeding in size said equivalent.

Cryolite used in the manufacture of aluminum remains on the free list.

ALUMINUM INDUSTRY

The domestic plants increased their output in response to the increased demand of automobile manufacturers, many of whom have apparently adopted the aluminum alloy engine, piston, and connecting rod as standard. The demand for closed cars has resulted in an increased use of molded shapes. Both aluminum bronze powder and foil are reported to be in better demand. Early in 1923 it was announced that the Aluminum Company of America had completed negotiations for giving financial assistance to the Norsk Aluminum Co.

A large amount of research work has been done during the year on various aluminum-copper and aluminum-silicon alloys. The technical press, particularly Chemical and Metallurgical Engineering, Metal Industry and bulletins of the American Institute of Mining and Metallurgical Engineers, the Bureau of Standards and the Bureau of Mines, contain many papers on this subject. An interesting new use of aluminum is in preparation of calorized metals, which are said to be extremely resistant to corrosion, developed by the research department of the General Electric Co.

ALUMINUM SALTS

DOMESTIC PRODUCTION AND CONSUMPTION

During 1922 manufacturers of aluminum salts consumed 162,976 long tons of bauxite, having an average value of $14 a ton at the plants, and 11,428 tons of high-alumina clay,

as compared with 64,380 tons of bauxite and 9,830 tons of clay in 1921. These figures do not include the bauxite made into alumina as a preliminary step in the manufacture of aluminum.

As shown in the following table, the production of all aluminum salts, except aluminum chloride, increased materially in 1922, as compared with 1921.

Aluminum salts produced in the United States, 1921-22

	1921		1922			
	Short tons	Value	Number of producers reporting	Short tons	Value: Total	Value: Average
Ammonia alum	6,284	$434,248	6	8,305	$535,759	$65
Sodium alum	*	*	3	9,506	570,372	60
Aluminum chloride	5,646	551,874	5	4,039	289,502	72
Aluminum sulphate:						
Commercial—						
General	151,859	5,472,236	19	231,387	6,090,166	26
Municipal	3,060	53,839	9	6,075	126,095	
Iron-free	11,003	592,216	7	19,162	968,645	51
Other aluminum salts†	6,961	442,771		3,006	232,448	
	‡184,813	‡7,547,184		281,480	8,812,987	

*Included under "Other aluminum salts."
†Includes potash alum (1 producer) and alumina, calcined and hydrated (2 producers).
‡Revised figures.

ALUMINUM SALTS INDUSTRY

It is rumored that one of the companies treating alunite near Marysvale, Utah, and the Stauffer Chemical Co., at Stege, Calif., will begin the manufacture of aluminum sulphate during 1923.

The Bureau of Mines has recently published a paper by Ralston[1] on the manufacture and uses of aluminum chloride, in which he brings out the fact that with cheap aluminum chloride the potential demand for this chemical by the petroleum refining industry is 1,000,000 tons a year. The various processes of manufacture are given in outline, and the suggestion is made that aluminum silicates could probably be used as raw materials.

1. Ralston, O. C., Aluminum chloride, its manufacture and uses: Bur. Mines Tech. Paper 321, 1923.

In the chapter on bauxite and aluminum in Mineral Resources for 1921 brief mention was made of the experiments on the use of aluminum sulphate for the treatment of impermeable soils, which have been carried out under the direction of Dr. C. S. Scofield,[2] of the United States Department of Agriculture. These experiments indicate that soil impermeability is due to the formation of gelatinous silicates, chiefly sodium silicates rather than "black alkali," and that this soil condition can be remedied by treatment with alum or aluminum sulphate. Treatment with 2 tons to the acre has been shown by experiments to be beneficial, but some soils may require treatment with as much as 10 tons to the acre. Natural alum, such as the magnesium-aluminum sulphate, pickeringite, that is found in several places in the Western States, has been successfully used.

The apparent consumption of aluminum salts in the United States in 1922 is shown below. The imports have not been shown in detail under previous tariff acts, though the tariff of 1922 mentions several classes of aluminum chemicals, and the only salt exported is aluminum sulphate.

Aluminum salts consumed in the United States, 1918-1922

Year	Domestic production		Imports		Exports*		Apparent consumption	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1918	230,505	$8,047,707	231	$18,519	*	*	230,736	$8,066,226
1919	223,547	8,189,519	343	21,877	*	*	223,890	8,211,396
1920	258,009	9,968,174	1,340	69,896	*	*	259,349	10,038,070
1921	†184,813	†7,547,184	1,009	45,963	*	*	185,822	7,593,147
1922	281,480	8,812,987	2,889	116,971	13,225	$388,447	271,144	8,541,511

*Figures not separately shown prior to 1922.
†Revised figures.

The Geological Survey attempted to collect and publish more detailed figures of consumption of aluminum salts for 1922. Circulars were sent to all the commercial producers to ascer-

2. Scofield, C. S., Quality of irrigation water in relation to land reclassification: Jour. Agr. Research, vol. 21, pp. 265-278, May 16, 1921; The cause of hard lands: Recl. Record, vol 12, pp. 520-522, November, 1921; Report on experimental investigations of the use of aluminum sulphate on alkali land on Reclamation Service stations: Recl. Record, vol. 13, pp.4-5, January, 1922; The effect of alum on silicate colloids: Washington Acad. Sci. Jour., vol. 11, p. 438, Nov. 4, 1921.

tain their wishes, but the results of this canvass showed that the great majority of producers of aluminum salts did not wish more detailed statistical information concerning the industrial and regional consumption of their products.

TARIFF

Under the tariff act of 1922 several aluminum salts not covered under the tariff of 1913 are subject to special rates of duty. Under the tariff of 1913 all aluminum salts were dutiable at 15 per cent ad valorem. Paragraph 6 of schedule 1, chemicals, in the act of 1922 is of particular interest to producers and consumers of aluminum chemicals.

PAR. 6. Aluminum hydroxide or refined bauxite, one-half of 1 cent per pound; potassium aluminum sulphate or potash alum and ammonium aluminum sulphate or ammonia alum, three-fourths of 1 cent per pound; aluminum sulphate, alum cake, or aluminous cake, containing not more than 15 per centum of alumina and more iron than the equivalent of one-tenth of 1 per centum of ferric oxide, three-tenths of 1 cent per pound; containing more than 15 per centum of alumina or not more iron than the equivalent of one-tenth of 1 per centum of ferric oxide, three-eighths of 1 cent per pound; all other aluminum salts and compounds not specially provided for, 25 per centum ad valorem.

ALUMINOUS REFRACTORIES

Bauxite refractories or high alumina refractories are finding wider markets, and some new producers entered into this field in 1922. The Geological Survey has not been able to interest the producers of refractory aluminus products sufficiently to obtain accurate and complete statistics of the industry. That this industry is expanding is shown by the growing demand for bauxite and high-alumina clays by ceramists all over the country. In 1922 the makers of refractory brick took 230 tons of bauxite and 36,990 tons of high-alumina clay. Kyanite, sillimanite, and andalusite as possible sources of aluminous raw materials have already been mentioned. That sillimanite itself may be used as a refractory has been indicated.* Considerable discussion of aluminous abrasives took place at the twenty-fifth meeting of the American Ceramic Society recently held in Cleveland.†

*Greaves-Walker, Soc. Chem. Industry (London) Jour., vol. 41, pp. 13t-14t, 1922; abstract in Eng. and Min. Jou., vol. 113, p. 536, 1922.
†Abstract in Chem. and Met. Eng., vol. 28, p. 394, 1923.

Aluminous refractory brick are sold in various shapes, the alumina content of which ranges from 50 to 76 per cent.

BAUXITE ABRASIVES

During 1922 makers of artificial aluminous abrasives purchased 19,270 tons of bauxite, as compared with 6850 tons in 1921. It is therefore evident that the industry was in much better shape than during the depression. Detailed statistics of production of aluminous abrasives for recent years are not available for publication, but they are combined with figures of output of silicon carbide abrasives in the chapter on abrasive materials. Under the tariff of 1922 artificial abrasives in ground form are dutiable at 1 cent a pound and in manufactured form at 20 per cent ad valorem. Emery, corundum, and crude artificial abrasives are on the free list.

BAUXITE PRODUCERS IN ALABAMA IN 1922

The Republic Mining and Manufacturing Co., near Rock Run, Cherokee County Ala.

CEMENT.

Eugene A. Smith

Portland Cement

RESOURCES.

ALABAMA contains large supplies of limestone, chalk, clay and shale well adapted to Portland cement manufacture, and widely distributed throughout the State. Coal and labor are abundant and cheap, transportation facilities are excellent, and many of the best limestone and chalk localities are situated on navigable rivers, giving ready access to cheap water transportation to Galveston, New Orleans, Mobile, Charleston, and other ports of the Gulf and Atlantic Coasts. This advantage of location was immensely increased with the opening of the Panama Canal for cement plants located in Alabama are more than a thousand miles nearer to the Isthmus than their nearest possible competitors.

The limestones and shales of the northern part of the State lie so close to each other, and above all so close to the great coal mines which must supply the fuel, that the establishment of Portland cement plants near the coal mines would give to this industry in Alabama, the same advantages which the proximity of the iron ore, the coal, and the stone has given to the iron industry, and which has placed our State beyond competition.

As a Portland cement mixture, ready for burning, consists approximately of 75 per cent lime carbonate and 25 per cent of clayey matter, the material furnishing the lime carbonate is necessarily of more economic importance than that from which the silica and alumina are derived. In consequence, a Portland cement plant is usually located in the immediate vicinity of a suitable limestone, while the clay or shale required to complete the mixture may be brought some distance.

The Limestone formations in North Alabama which can supply the stone adapted for use in cement manufacture are the Trenton or Pelham limestone and the Bangor or Subcarboniferous. In close proximity to both these limestone formations are the shales of the Clinton, Subcarboniferous and Coal Measures.

At the present time there are two cement plants in North Alabama, namely, the Atlas Portland Cement Co., located at Leeds in Jefferson County, and the National Cement Co., located at Ragland in St. Clair County. Both of these plants make use of the hard Trenton limestone, and the Standard Cement Co., according to Burchard of the U. S. Geological Survey, uses the shale of the Clinton formation whilst the Ragland Company makes use of the shales of the Coal Measures. Up to the present time no establishment is utilizing the Bangor limestone.

In Middle Alabama the soft, chalky cretaceous limestone of the Selma Chalk is the material utilized by the Alabama Portland Cement Co., at Spocari, near Demopolis. The same company makes use of residual clays overlying and derived from the weathering of the Selma Chalk. No production from this plant was reported from 1914 until 1920 when the plant resumed operation.

In Southern Alabama the St. Stephens limestone outcropping east and west across the State, furnishes excellent material for Portland cement manufacture, using either residual clays from decomposition of the limestone, or the clays of the Grand Gulf formation which are almost everywhere in close proximity to the limestone.

Puzzolan Cement.

During the past nine years only one establishment in Alabama, the Southern Cement Company, North Birmingham, has been engaged in the manufacture of slag cement, using the material from the furnaces about Birmingham. The production is included in the returns for Portland cement and cannot be given separately.

In 1922 the quantity of cement sent to the market was 2,324,116 barrels valued at $4,135,684 as compared to 1,714,286 barrels valued at $3,466,223 in 1921. Shipments showed an increase of 35.6% and in value of 19.2% over that of 1921. The average price per barrel was $1.78 a decrease of 11.8% over the previous year.

The annual capacity was 2,413,000 barrels of finished cement. It is evident then that the industry operated at 96.3% of capacity. Stocks on hand showed a decrease of 48.4% over the preceding year.

Portland cement produced, shipped, and in stock in the United States, 1921 and 1922, by States

State	Production						Shipments							Stock		
	Active plants		Barrels		Increase or decrease, 1922 (per cent)		1921		1922		Average factory price per barrel		Increase in quantity, 1922 (per cent)	Barrels		Increase or decrease, 1922 (per cent)
	1921	1922	1921	1922			Barrels	Value	Barrels	Value	1921	1922		1921 (revised)	1922	
Alabama	3	3	1,743,287	2,290,884	+31		1,714,286	$3,466,223	2,324,116	$4,135,684	$2.02	$1.78	36	68,638	35,406	—48
California	9	9	7,302,784	8,711,515	+19		7,180,700	16,856,258	9,041,788	20,478,577	2.35	2.26	26	564,713	235,441	—58
Illinois	4	4	5,587,825	6,407,129	+15		5,237,510	9,092,982	6,554,945	10,584,171	1.74	1.61	25	772,955	625,139	—19
Iowa	4	4	4,590,920	4,272,432	— 7		4,151,439	7,439,983	4,475,074	7,709,313	1.79	1.72	8	993,090	790,447	—20
Kansas	7	7	3,781,494	4,634,287	+23		3,643,582	7,253,944	4,556,517	8,138,268	1.99	1.79	25	540,877	618,647	+14
Michigan	11	12	5,777,533	6,243,805	+ 8		5,680,156	10,300,289	6,349,751	11,145,573	1.81	1.76	12	759,703	641,432	—16
Missouri	5	5	4,446,091	6,170,633	+39		4,375,712	8,034,540	6,239,144	10,457,557	1.84	1.68	43	640,932	572,444	—11
New York	8	9	5,294,188	5,922,706	+12		4,993,341	9,403,015	6,194,663	10,694,426	1.88	1.73	24	784,607	516,365	—34
Ohio	5	5	2,563,773	2,835,243	+11		2,518,723	4,615,492	2,913,034	5,243,687	1.83	1.80	16	238,678	161,797	—32
Pennsylvania	22	22	27,628,598	33,276,093	+20		26,622,367	46,881,625	34,023,695	55,528,002	1.76	1.63	28	3,410,698	2,659,452	—22
Texas	5	5	2,668,741	3,628,756	+36		2,514,045	5,902,863	3,730,477	7,515,932	2.35	2.01	48	296,296	190,762	—36
Washington	4	4	1,678,863	1,942,781	+16		1,612,891	4,080,785	1,951,414	4,684,624	2.53	2.40	21	255,293	246,660	— 3
Other States*	28	29	25,777,952	28,453,720	+10		25,262,395	47,450,416	29,346,598	50,854,616	1.88	1.73	16	2,866,087	1,973,246	—31
Total	115	118	98,842,049	114,789,984	+16		95,507,147	180,778,415	117,701,216	207,170,430	1.89	1.76	23	12,192,567	9,267,238	—24

*Colorado, Georgia, Indiana, Kentucky, Maryland, Minnesota, Montana, Nebraska, New Jersey, Oklahoma, Oregon, Tennessee, Utah, Virginia, and West Virginia.

RECOVERY OF POTASH FROM PORTLAND CEMENT MATERIALS.

It has been noticed that the flue dust in a cement plant often contains a notable percentage of potash, and efforts have been made to utilize this dust in the extraction of potash. Flue dust from the Standard Cement Plant shows 2½ per cent, and above potash, and it is in contemplation to utilize this, and the suggestion is also made to use feldspar in the manufacture. Up to the present time, however, there has been no commercial production of any potash from this source.

CEMENT PRODUCERS IN 1922

Southern Cement Co., Birmingham, Alabama. Works at North Birmingham, Jefferson County, Alabama.

Atlas Portland Cement Co., 25 Broadway, New York City. Works at Leeds, Jefferson County.

National Cement Co., Ragland, Alabama. Plant at Ragland, St. Clair County.

Gulf States Portland Cement Co., Demopolis, Alabama. Plant at Spocari, Marengo County.

CLAY.

Jefferson Middleton and Eugene A. Smith

CLAY available for the manufacture of clay products is one of the most widely distributed of our minerals. Hence there are clay-working plants scattered over every state and territory in the Union. Miners of the low-grade clays are usually also the manufacturers, but as the higher grades of ware are reached, the rule is that fewer and fewer manufacturers are also miners, until in the highest grades of ware the rule is that the manufacturer buys and does not mine the clay he uses. The figures given in the following tables represent clay that is mined and not manufactured by the miner, but is sold as clay. The clay thus sold is small in quantity compared with the total production and includes mainly clay used for high-grade pottery and tile, for paper making, and for refractory products.

The year 1922 saw a number of clay producers idle, a decrease of 58% in the number of operators.

The total amount of clay mined in Alabama and sold as such in 1922 was 60,523 tons valued at $49,765 as compared to 46,852 tons valued at $48,736 in 1921. An increase of 13,671 short tons and an increase of value of $1,029. An increase of 29.1% in production and of value of 2.1%.

Following is a table showing the production and value of clay mined and sold in Alabama from 1911 to 1922 inclusive.

Production of clay in Alabama from 1911 to 1922 inclusive and a comparison of the production in 1922

YEAR	FIRE CLAY		MISCELLANEOUS CLAY		TOTAL	
	Quantity Short Tons	Value.	Quantity Short Tons	Value.	Quantity Short Tons	Value
1911	35,203	29,909			35,203	29,909
1912	38,552	31,414	4,500	2,000	43,052	33,414
1913	49,901	53,269	*	*	49,901	53,419
1914	27,973	34,607			27,973	34,607
1915	31,520	34,882	*	*	31,870	35,232
1916	40,235	50,618	1,244	435	41,479	51,053
1917	41,951	67,674			58,667	84,763
1918	49,516	48,611	532	582	50,048	49,193
1919	49,372	46,497	19,931	28,641	69,303	75,138
1920	45,612	51,220	1,900	39,790	47,512	91,010
1921	45,520	38,077	1,332	10,659	46,852	48,736
1922	55,483	44,355	4,820	4,750	60,523	49,765
Difference 1922	+ 9,963	+ 6,278	+ 3,488	— 5,909	13,671	1,029
Percentage	+ 21.9	+ 16.5	+ 262.0	— 55.5	29.1	2.1

*Not divulged but included in total.

RAW CLAY PRODUCERS IN 1922

Bibb County

Bibbville Fire Brick & Mfg. Co., Woodstock, Alabama.

Blount County

Lehigh Coal Company, Lehigh, Alabama.
Birmingham Clay Products Co., Sibleyville, Alabama.

Calhoun County

Kraus Research Laboratories, McFalls, Alabama.

DeKalb County

Ladd Fire Brick Co., Fort Payne, Alabama.

Escambia County

Spruce Pine Sand & Gravel Co., Spruce Pine, Alabama.

Jefferson County

Imperial Coal & Coke Co., Dixana, Alabama.
Bibby Coal Shale & Clay Co., Inc., Littleton, Alabama.

Talladega County

Anniston Refractories Co., Oxford. Alabama.

CLAY AND REFRACTORY PRODUCTS: 1922.

INTRODUCTION.

THIS report presents the statistics of production for establishments engaged, in 1922, in the manufacture of (1) brick and tile, (2) pottery, and (3) non-clay refractories. This census of production for the year intervening between those covered by the biennial censuses of manufactures was undertaken at the request of manufacturers and manufacturers' associations in order that the trade might have comparative statistics for successive years. The most important of these statistics were made public through the medium of a preliminary announcement or press summary under date of August 31, 1923.

The statistics for 1922 and 1921 are based upon reports made to the Bureau of the Census, and those for 1920 and prior years upon data collected by the Geological Survey. The census schedules for 1922 and 1921 called for the selling value, at the works, of the production "manufactured during the year, whether sold or on hand," whereas the schedules used by the Geological Survey called for the "value of the product of your own make marketed or used by you during the year, whether manufactured in that year or some previous year." Hence the statistics for 1922 and 1921 are not strictly on a par with those for the prior years, the comparability being affected to the extent that production has exceeded or fallen below sales.

The State of Alabama is rich in clays of many kinds yet it ranks low as a clay producing state, producing about one per cent of the clay products produced in the United States. The clay products in 1922 were valued at $2,798,255 as compared to $2,266,704 in 1921, an increase of $531,551 or 23.5 per cent. Though there are various clay products, only a few are of any great commercial importance, and the chief one is common brick valued at $805,589 or 29.8 per cent of the state total.

Fire brick was the Alabama clay product second in value, with face brick coming third and hollow tile or block next in order. The percentage increase in the production of fire brick

for 1922 over that of 1921 was 181.5; of hollow tile for the same period 139.8.

The pottery production of the State is of minor importance, constituting barely one per cent of the total value of the clay products produced in 1922. The output was valued at $26,100 in 1922 as compared with 22,862 in 1921.

The products consisted of stoneware and yellow and Rockingham ware, and red earthenware, including turpentine cups, etc. The latter represents about fifty per cent of the total production of pottery.

Owing to the change (noted above) in securing the clay product statistics, it seems advisable to include tables of production previously published. In order to avoid confusion due to this change, a separate comparative table for the years 1921-1922 based on the reports made the Bureau of Census is included.

In tabular form these statistics are given as follows:

Clay Products of Alabama, 1921-1922, compiled from U. S. Bureau of Census report

Class of Product	1922 Number of establishments	1922 Quantity	1922 Value Amount	1922 Value Average per unit	1922 Value Per cent distribution	1921 Number of establishments	1921 Quantity	1921 Value Amount	1921 Value Average per unit	1921 Value Per cent distribution	Per cent of increase or decrease (—) 1921-1922 Quantity	Per cent of increase or decrease (—) 1921-1922 Value
		Thous'ds					Thous'ds					
Common brick	26	88,530	$805,589	$9.10	1.1	36	89,298	$844,198	$9.45	1.5	—0.9	—4.6
Fire brick	4	15,480	444,737	28.73	1.4	4	5,499	218,390	39.41	0.9	181.5	103.6
Face brick	6	11,252	349,717	31.08	1.2	4	*	*	......	......	......	......
		Tons					Tons					
Hollow building tile or block	6	46,008	322,097	7.00	1.6	4	19,182	174,219	9.08	1.2	139.8	84.9
Drain tile	3	4,039	49,323	12.21	1.0	2	*	*	......	......	......	......
Red earthenware	6	......	15,300	......	0.5	8	......	10,800	......	0.5	......	41.7
Stoneware (except chemical) and yellow and Rockingham ware	3	......	10,800	......	0.2	4	......	12,062	......	0.2	......	—10.5
Unclassified	......	......	800,692	......	......	......	......	1,005,035	......	......	......	......
Total†	39	......	$2,798,255	......	......	48	......	$2,266,704	......	......	......	23.5

*Not at liberty to publish.
†Total number of establishments producing. Itemized list counts establishment for each product.

Clay products of Alabama, 1914-1921‡

PRODUCT	1914	1915	1916	1917	1918	1919	1920	1921
Brick:								
Common—								
Quantity	110,731,000	70,681,000	85,655,000	81,574,000	69,467,000	86,465,000	93,455,000	89,298,000
Value	$638,666	$382,092	$497,446	$557,920	$714,374	$1,183,917	$1,513,012	$844,198
Average per M.	$5.77	$5.41	$5.81	$6.84	$10.28	$13.72	$16.18	$9.47
Vitrified—								
Quantity	18,679,000	29,018,000	25,143,000	21,319,000	25,631,000	21,891,000	-----	16,052,000
Value	$248,525	$374,387	$311,317	$316,914	$416,463	$524,025	-----	$339,301
Average per M.	$13.31	$12.90	$12.38	$14.87	$16.25	$23.90	-----	$21.10
Front—								
Quantity	*	5,815,000	6,968,000	*	*	*	8,013,000	*
Value	*	$58,212	$77,470	*	*	*	$221,986	*
Average per M.	$11.42	$10.01	$11.12	$12.17	$20.05	$24.30	$27.70	-----
Fancy, value	*	-----	-----	-----	-----	-----	-----	-----
Fire, value	$167,021	$145,535	$278,749	$502,936	$547,930	$373,836	$440,180	$218,390
Draintile, value	$6,838	$9,330	*	$17,261	*	*	*	$6,785
Sewer pipe, value	*	*	*	*	*	*	*	$418,667
Fireproofing, value	*	$62,114	$80,523	$106,700	$163,126	$293,111	$333,595	*
Pottery:								
Red earthenware, including turpentine cups, value	$4,800	$6,741	$13,551	$6,060	$4,023	$5,122	$16,250	$7,750
Stoneware and yellow and Rockingham ware, value	$11,742	$8,556	$9,254	$12,671	$11,301	$25,131	$19,090	$35,062
Miscellaneous,† value	$496,431	$146,055	$251,991	$488,054	$301,887	$705,877	$460,780	$249,424
Total value	$1,574,023	$1,193,022	$1,520,301	$2,106,516	$2,159,104	$3,111,019	$3,422,186	$2,536,078
Number of active firms reporting	70	65	57	53	49	64	60	48
Rank of state	20	24	25	19	18	-----	-----	22

*Included in "Miscellaneous." †Miscellaneous includes drain tile, sewer pipe, stove lining, silica brick, and face brick.
‡U. S. Geological Survey.

BRICK AND TILE PRODUCERS, 1922

Chattahoochee Brick Co., Eufaula, Barbour County, Ala. (1)

Birmingham Clay Products Co., Birmingham, Ala. Plant, Sibleyville, Blount County, Ala. 1-3-12.

W. T. Greenleaf, Oxford, Calhoun County, Ala. (12)

Elba Brick Co., Elba, Coffee County, Ala. (1)

Consolidated Brick Co., River Falls, Covington County, Ala. (1)

Cullman Brick Co., Cullman, Ala. Plant at Smithdale, Cullman County, Ala. (1)

T. L. Rosser, 2½ miles west of Newton, Dale County, Ala. (1)

Keego Brick Co., Brewton, Escambia County, Ala. (1)

Strong Brick & Lumber Co., Brewton, Escambia County, Ala. (1)

Gadsden Clay Products Co., Gadsden, Ala. East Gadsden, Etowah County, Ala. (1)

Johnson Brick Co., Attalla, Etowah County, Ala. (1)

H. F. Horn & Sons, Greensboro, Hale County, Ala. (1)

Alabama Clay Products Co., Birmingham, Ala. Plant, Bessemer, Jefferson County (1-3-12).

The Standard Brick Co., Bessemer, Jefferson County, Ala. (1)

Bibby Coal Shale & Clay Co., Littleton, Ala. Bibby, Jefferson County, Ala. (1)

Southern Sewer Pipe Works, Birmingham, Ala. (7-9-10-14)

Robertson Brick Co., Birmingham, Ala. (1)

Birmingham Hollow Tile Co., Birmingham, Ala. Plant, Ensley, Ala. (7)

Harbison-Walker Refractories Co., Pittsburg, Pa. Fairfield, Ala. (12)

Stephenson Brick Co., Birmingham, Ala. Lovic, Jefferson County, Ala. (1-3)

Roper-Strauss-Ferst Co., Inc., Birmingham, Ala. Plant, North Birmingham, Ala. (7-a and 7-b)

Southern Clay Manufacturing Co., Chattanooga, Tenn. Plant, North Birmingham, Alabama. (2) Plant at Warrior, Ala. (2)

S. E. Hauerwas, Florence, Lauderdale County, Ala. (1)

Huntsville Brick Co., Inc., North Huntsville, Madison County, Ala. (1)

Jenkins Brick Co., Montgomery, Montgomery County, Ala. (1-7-9)

Alabama Brick & Tile Co., Decatur, Morgan County, Ala. (1-3-7-9)

M. P. Garver, Roanoke, Randolph County, Ala. (1)

Bickerstaff Brick Co., Columbus, Ga. Plant, Brickyard, Russell County, Ala. (1)

Dixie Brick Co., Columbus, Ga. Plant, Dixieland, Ala. (1-3)

Alphons Custodis Chimney Construction Co., New York, N. Y. Plant at Ragland, St. Clair County, Ala. (1-3-7)

Childersburg Brick Co., Inc., Childersburg, Talladega County, Alabama (1).

F. M. Van Deusen, Sylacauga, Talladega County, Ala. (1)

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(1) Common brick; (2) vitrified brick or block; (3) face brick. (7) Hollow building tile, (a) partitions, load bearing, etc., (b) floor arch, silo tile, corn crib tile conduits, radial chimney blocks, fireproofing. (9) Drain tile; (10) sewer pipe; (12) fire brick; (14) other clay products.

POTTERY PRODUCERS, 1922

W. I. Mulder, Wetumpka, Ala. Works at Wetumpka, Elmore County, Ala. (1)

Spruce Pine Pottery Co., Franklin County, Ala. (1)

W. M. Miller, Spratt, Ala. Works at Marion, Perry County, Ala. (1)

Boggs & Bro., Rock Mills, Ala. Works at Rock Mills, Randolph County, Ala. (1-3)

Sterrett Pottery Works, Sterrett, Ala. Works in Shelby County, Ala. (1-3)

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(1) Red earthenware (flower pots, etc.)
(3) Stoneware (except chemical) and yellow and Rockingham ware.

COAL.

E. W. Parker and C. E. Lesher

Introductory.

THE great Appalachian coal region which furnishes over two-thirds of the coal production of the United States and which extends from Ohio and Pennsylvania on the north in a gradually narrowing belt through Eastern Kentucky and Tennessee has its southern terminus in a considerably broadened area that occupies a large part of the northern half of Alabama. The coal-bearing formations of Alabama underlie about 8,400 square miles and are divided into four distinct basins, the Coosa, the Cahaba, and the Warrior, named from the rivers which drain them, and the Plateau, which includes Blount, Lookout, and Sand or Racoon Mountains. By far the most important basin in area and in production is the Warrior, which includes all of Walker County, most of Jefferson, Tuscaloosa, and Fayette counties, and smaller parts of Blount, Cullman, Winston and Marion counties. The area known to contain coal is approximately 4,000 square miles, or one-half the total coal area of the State, and contributes about 85 per cent of the total production.

There are several distinct coal groups in the basin, the most important of which are the Brookwood, the Pratt, and the Mary Lee, designated by the names of their principal beds. The Mary Lee group includes the Blue Creek, the Jagger, and the Newcastle beds, most of which are mined in places. The Brookwood, the Pratt, and the Mary Lee produce most of the coking coal mined in the State, and more than half of all of the coal mined in the district.

The Cahaba Basin, second in importance, is a long narrow syncline, 68 miles long and about six miles wide, southeast of the Warrior, and occupies parts of St. Clair, Jefferson, Shelby and Bibb counties. There are many workable beds, and the total quantity of coal in the basin is large. The production is something over 16 per cent of the total for the State.

The Coosa Basin is a deep syncline east of the Cahaba and parallel with it, extending across Shelby and St. Clair counties.

It is also long and narrow, 60 miles long by six miles wide. It has not been thoroughly explored, but in different parts of the area from two to twelve beds, three or more feet in thickness, have been reported.

The Plateau field embraces parts of Blount, Etowah, DeKalb, Cherokee, Marshall, and Jackson counties, and although it has an area underlain by coal four times that of the Cahaba and the Coosa combined, the resources in Alabama are comparatively small. There are four to six beds locally workable. So far as known, the earliest record of the existence of coal in Alabama was made in 1834. The first statement of production in the State is contained in the United States census report for 1840, in which year the production is given at 946 tons. The census report for 1850 does not mention any coal production for the State, and the next authentic record is contained in the census statistics of 1860, when Alabama is credited with an output of 10,200 short tons. The mines of Alabama were probably worked to a considerable extent during the Civil War, but there are no records of the actual production until 1870, for which year the United States census reports a production of 11,000 tons. Ten years later the production had increased to 323,972 short tons, but the development of the present great industry really began in 1881 and 1882, when attention was directed to the large iron deposits near the city of Birmingham and thus the great "boom" of that city and vicinity was inaugurated. By 1885 the coal production of the State had increased to nearly 2,500,000 tons. Then followed a period of relapse and liquidation, which lasted two years, after which business settled down to a conservative and rational basis and has since developed steadily. In 1902 the coal production of the State reached a total of more than 10,000,000 tons, and reached the maximum of 17,678,522 tons in 1913, since which time there has been a decrease, until 1916, when the maximum of 1913 was exceeded, as may be seen in the table below.

PRODUCTION.

The statistics of production in Alabama from 1840 to the close of 1922 are shown in the following table:

Production of coal in Alabama from 1840 *to* 1921, *in short tons.*

Year	Quantity	Year	Quantity	Year	Quantity	Year	Quantity
1840	946	1860	10,200	1880	323,972	1900	8,394,275
1841	1,000	1861	10,000	1881	420,000	1901	9,099,052
1842	1,000	1862	12,500	1882	896,000	1902	10,354,570
1843	1,200	1863	15,000	1883	1,568,000	1903	11,654,324
1844	1,200	1864	15,000	1884	2,240,000	1904	11,262,046
1845	1,500	1865	12,000	1885	2,492,000	1905	11,866,069
1846	1,500	1866	12,000	1886	1,800,000	1906	13,107,963
1847	2,000	1867	10,000	1887	1,950,000	1907	14,250,454
1848	2,000	1868	10,000	1888	2,900,000	1908	11,604,593
1849	2,500	1869	10,000	1889	3,572,983	1909	13,703,450
1850	2,500	1870	11,000	1890	4,090,409	1910	16,111,462
1851	3,000	1871	15,000	1891	4,759,781	1911	15,021,421
1852	3,000	1872	16,800	1892	5,529,312	1912	16,100,600
1853	4,000	1873	44,800	1893	5,136,935	1913	17,678,522
1854	4,500	1874	50,400	1894	4,397,178	1914	15,593,422
1855	6,000	1875	67,200	1895	5,693,775	1915	14,927,937
1856	6,800	1876	112,000	1896	5,748,697	1916	18,086,197
1857	8,000	1877	196,000	1897	5,893,770	1917	20,068,074
1858	8,500	1878	224,000	1898	6,535,283	1918	19,184,962
1859	9,000	1879	280,000	1899	7,593,416	1919	15,536,721
						1920	16,140,099
						1921	12,568,899
						1922	18,324,740
						Total	405,384,509

The production of coal in Alabama in 1922 was 18,324,740 tons, valued at $42,856,000 as compared to 12,568,899 tons valued at $38,713,000 in 1921. An increase in production of 45 per cent and in value of 10 per cent.

The production of soft coal rose steadily from the beginning of the year until March. The shut down in all the organized districts except western Kentucky, due to the coal strike, created an increased demand for Alabama coal and much was shipped out of the State. The months of April, May, and June showed increased production in local fields. This was curtailed by the shortage of transportation equipment due to the railway shopmen's strike which started July 1st.

Coal produced in Alabama and distribution at mine in net tons
1921 *and* 1922

DISTRIBUTION	1921	1922
Loaded at mines for shipment	11,834,609	17,376,060
Sold to local trade or used by employees	313,125	360,811
Used at mines for steam and heat	292,807	290,187
Made into coke at mines	128,358	*
Total quantity	12,568,899	18,324,740
Total value	$38,713,000	$42,856,000
Average value per ton	$3.00	$2.34

*Not at liberty to disclose.

Statistics of production of coal in Alabama in 1922

COUNTY.	Loaded at mines for shipment. (net tons)	Sold to local trade and used by employees (net tons)	Used at mines for steam and heat (net tons)	Made into coke at mines. (net tons)	Total quantity (net tons)	Total value.	Average value per ton.	Number of Employees: Underground: Miners, Loaders, Etc.*	Number of Employees: Underground: All others	Number of Employees: Surface	Number of Employees: Total	Average number of days worked
Alabama:												
Bibb	1,014,072	5,259	20,358	....	1,039,689	$2,591,000	$2.49	1,106	482	321	1,909	203
Blount	313,767	1,930	5,263	....	320,960	807,000	2.51	463	70	115	648	176
Etowah	95,042	2,319	1,449	....	98,810	227,000	2.30	166	20	33	219	228
Jefferson	7,790,054	109,907	161,470	123,436	8,184,867	18,866,600	2.31	6,568	3,297	1,845	11,710	229
St. Clair	779,952	4,310	19,035	....	803,297	1,898,000	2.36	616	175	131	922	252
Shelby	596,334	12,297	18,510	....	627,141	1,901,000	3.03	882	334	238	1,454	205
Tuscaloosa	966,227	19,952	16,339	174,246	1,176,764	2,271,000	1.93	984	362	234	1,580	259
Walker	5,553,635	201,742	41,902	....	5,797,279	13,502,000	2.33	5,539	1,710	2,021	9,270	195
Winston	27,795	585	....	....	28,380	79,000	2.79	75	23	21	119	124
Other counties†	142,882	2,510	5,861	....	151,253	426,400	2.82	216	55	67	338	169
Total, excluding wagon mines	17,279,760	360,811	290,187	297,682	18,228,440	42,569,000	2.34	16,615	6,528	5,026	28,169	215
Wagon mines served by rail	96,300	....	....	....	96,300	287,000	2.98	....	....	....	....	....
Grand total	17,376,060	360,811	290,187	297,682	18,324,740	42,856,000	2.34	....	....	....	....	....

*Includes also shot-firers. †Cullman, Franklin, and Marion.

Coal produced in Alabama, 1917-1922, in net tons

COUNTY	1917	1918	1919	1920	1921	1922	Increase or Decrease 1922	Percentage Increase or Decrease in 1922
Bibb	1,624,623	1,374,548	1,034,099	968,001	643,992	1,039,689	+ 395,697	+ 61.4
Blount	266,729	315,095	283,606	285,384	302,390	320,960	+ 18,570	+ 6.12
Cullman, Jackson, and Marion	129,930	140,600	119,390	121,886	84,794	....	....	....
Etowah	154,265	130,538	91,397	76,568	75,107	98,810	+ 23,703	+ 31.5
Jefferson	10,453,093	9,379,957	7,548,567	7,719,910	5,864,475	8,184,867	+ 2,320,392	+ 39.6
St. Clair	836,995	832,348	668,304	562,209	646,212	803,297	+ 157,085	+ 24.3
Shelby	781,858	744,111	562,863	586,996	460,496	627,141	+ 166,645	+ 36.0
Tuscaloosa	923,735	1,032,705	872,778	914,186	538,402	1,176,764	+ 638,362	+118.0
Walker	4,844,480	5,156,269	4,290,298	4,768,457	3,919,884	5,997,279	+ 1,877,395	+ 47.9
Winston	43,900	76,527	65,006	36,195	33,150	28,380	— 4,770	— 14.4
Small mines	8,466	2,264	413	....	....	....	....	....
Total quantity	20,068,074	19,184,962	15,536,721	16,140,099	12,568,899	18,324,740	+ 5,755,841	+ 45.0
Total value	$45,616,992	$54,752,329	$45,937,681	$58,637,010	$38,713,000	$42,856,000	4,143,000	+ 10.0

*Includes Jackson County. †Marion County only.

LABOR STATISTICS

Men employed in the mines of Alabama in 1920, 1921, 1922

NATURE OF WORK	1920	1921	1922
Underground	20,355	21,173	23,143
Surface	5,185	4,636	5,026
Total	25,540	25,809	28,169
Average number of days worked	247	166	215

Statistics of labor employed in coal mines of Alabama, 1908-1922

YEAR	Number of days active.	Average Number Employed.
1908	222	19,197
1910	249	22,210
1911	227	22,707
1912	245	22,613
1913	255	24,552
1914	226	24,042
1915	223	22,591
1916	262	25,308
1917	273	28,386
1918	278	26,221
1919	239	26,874
1920	247	25,540
1921	166	25,809
1922	215	28,169

Coal produced per man and average number of days per year in Alabama from 1920 *to* 1922, *inclusive*

YEAR	Days mine worked	Average tonnage	
		Per year	Per day
1920	247	632	2.56
1921	166	458	2.76
1922	215	650	3.02

Mining Methods.

The term "mining method" as used here refers to the manner in which the coal is broken down in the mine and not to the system of mining, or by room and pillar or long wall. In the mine the coal is either blasted from a solid face—shot from the solid—as in hard-rock mining, or is shot loose or otherwise broken down after a preliminary cut into the coal has been made. This cut may be made by hand or machine. Underground methods are therefore classified as shot from the solid, mined by hand and mined by machines. An increasing quantity of coal is being recovered each year by stripping the cover from the bed in open pits by steam shovels. The bed thus exposed is for the most part shattered by powder and shoveled into cars by hand, although in places it is picked up directly by small steam shovels.

Opposition to shooting from the solid has developed, because it is injurious to the mining property in that the unusual charges of powder weaken the roof and pillars, which increases the liability to falls of roofs and coal, the most prolific cause of fatal accidents to coal miners. Another objection to this method is that the heavy charges of powder required to blow down the coal where it has not been previously undercut or sheared cause the production of a very high proportion of fine coal and render the lump coal so friable that it disintergrates in handling and in transportation. With the growing use of mechanical stokers and of powdered coal the latter objection is losing much of its force, but the danger attending the method has been in no wise diminished, and it is forbidden by law in some of the coal-mining states. Shooting off the solid is still practiced in Alabama, but it is not to be advised.

There are no statistics available for 1922 to show the percentage of coal mined by the different methods, the number of machines in use, or the amount of coal mined by machines.

Coal-Washing Operations.

Not all coal can be cleaned by hand picking. Some coal beds or parts of beds have layers or benches of slate and bone or contain more than the allowable quantity of sulphur in the form of iron pyrite so thoroughly mixed with the coal that crushing is necessary to free the coal from the refuse. To

clear such coal washing is resorted to and the coal, being lighter than the refuse, is separated by currents of water. Coal is also cleaned in the dry state.

At present there is no information available to show the distribution and consumption of the coal produced in 1922.

AVERAGE VALUE OF ALABAMA COAL.

Average value per short ton for coal at mines in Alabama since 1913

1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
$1.31	$1.34	$1.28	$1.37	$2.27	$2.85	$2.96	3.63	$3.00	$2.34

COAL PRODUCERS, 1922

BIBB COUNTY

Bessemer Coal, Iron and Land Co., Birmingham. Mines Belle Ellen No. 1, 8, 9 and 12.

Alabama Blocton Coal Co., Blocton, Ala. Blocton No. 3.

Tenn. Coal, Iron and R. R. Co., Birmingham, Ala. Blocton No. 9, 10.

Blocton Cahaba Coal Co., Coleanor, Ala. Mine at Coleanor, Alabama.

Garnsey Coal Co., Garnsey, Ala. Mine at Garnsey, Ala.

Hills Creek Mining Co., West Blocton, Ala. Mine at Hills Creek, near West Blocton.

Roden Coal Co., Marvel, Ala. Marvel Nos. 2, and 3.

Bibb Coal Co., Birmingham, Ala. Norris mine near Blocton, Ala.

Little Cahaba Coal Co., Piper, Ala. Mines Piper No. 1 and 2.

Red Feather Coal Co., Blocton, Ala. Red Feather mine at Blocton.

Blocton Mining Co., West Blocton, Ala. Mine, Smiths Shaft, near Blocton, Alabama.

Cahaba Red Ash Coal Co., West Blocton, Ala. Welch mine.

Moffat Coal Co., St. Louis, Mo. Mine at Dixie on M. & O. R. R.

BLOUNT COUNTY

Inland Coal and Iron Co., Inland, Ala. Mine Inland No. 1.

Lehigh Coal Co., Lehigh, Ala. Lehigh mine.

Moss & McCormick, Birmingham, Ala. Nyota mine, near Warrior, Ala.

Montgomery Coal Co., Warrior, Ala.

CULLMAN COUNTY

Stout's Mountain Coal Co., Hanceville, Ala. Stout's Mountain mine at Hanceville, Ala.

ETOWAH COUNTY

Jackson & Clayton, Alabama City, Ala. Black Creek mine near Alabama City, Ala.

W. P. Clayton, Gadsden, Ala. Clayton mine.

Jackson Coal Co., Alabama City, Ala. Jackson mine.

Gulf States Steel Co., Birmingham, Ala. Mines at Altoona Drift No. 1, 2, and Vanzandt.

Sligo Coal Mining Co., Gadsden, Ala. Mine at Sligo, Ala.

FRANKLIN COUNTY

Riley Taylor Coal Co., Phil Campbell, Ala.

JEFFERSON COUNTY

Ajax Coal and Mining Co., Johns, Ala. Ajax mine.

Blue Creek Mining and Mfg. Co., Birmingham, Ala. Apache mine.

Pratt Consolidated Coal Co., Birmingham, Ala. Arcadia, Banner, Eldorado, Jett, New Pratt, Praco.

Tennessee Coal, Iron and R. R. Co., Birmingham, Ala. Mines at Mayview, Docena, Edgewater, Hamilton Slope, Pratt No. 1, 2, 3 and 7, and Wylam No. 1, 2, 3, 4, 5, 6, 7, 8, 10, 14.

American Fuel Co., Warrior, Ala. Beltona mine.

Sloss-Sheffield Steel and Iron Co., Birmingham, Ala. Bessie, Coalburg No. 1, Flat Top, New Found, Blossburg Nos. 2, 3, and 4.

Bibby Coal, Shale and Clay Co., Littleton, Ala. Bibby mine.

McMath Sons Coal Co., Sayreton, Ala. Big four mine.

H. P. Stith Mining Co., Republic, Ala. Big Oak mine.

Birmingham Water Works Co., Birmingham, Ala. Birmingham Water Works mine.

Burgin Coal Co., Birmingham, Ala. Black Creek mine.

Imperial Coal & Coke Co., Birmingham, Ala. Bradford, Dixiana mines.

Brookside Pratt Mining Co., Birmingham, Ala. Buckeye, Cardiff No. 2 and 3, Coalburg, and Pinkney No. 1, 2 and 4.

East Pratt Coal Co., Birmingham, Ala. Clift mine.

Woodward Iron Co., Woodward, Ala. Dolomite No. 1 and 3, Mulga.

South Pratt Coal Co., Birmingham, Ala. East Blossburg mine.

G. D. Etter, Jr., Warrior, Ala. Elvista mine.

New Found Creek Coal Co., Morris, Ala. Eulamo mine.

Hoskins Mining Co., Birmingham, Ala. Graves mine.

North Pratt Coal Co., Birmingham, Ala. Hillhouse mine.

Central Alabama Coal Co., Kimberly, Ala. Kimberly No. 2, and 3.

Birmingham Trussville Iron Co., Birmingham, Ala. Labuco mine.

The Alabama Coal Co., Birmingham, Ala. Lewisburg mine.

Majestic Coal Co., Birmingham, Ala. Majestic mine.

New Castle Coal Co., Birmingham, Ala. New Castle No. 2, and 6

Flat Creek Mining Co., Birmingham, Ala. North Labuco mine.

North Birmingham Coal Co., Sayreton, Ala. O'Hare mine.

Phenix Coal Co., Ensley, Ala. Phenix mine.

E. P. Rosemond, Birmingham, Ala. Powell mine.

Franklin Coal Mining Co., Birmingham, Ala. Powhattan mine.

Republic Iron & Steel Co., Birmingham, Ala. Palos, Sayreton, Thompson, and Warner.

Turkey Creek Coal Co., Morris, Ala. Rogers mine.

Gulf States Steel Co., Birmingham, Ala. Sayre, and Virginia mines.

American Fuel Co., Montgomery, Ala. Beltona mine.

Birmingham Clay Products Co., Birmingham, Ala. Langely mine.

Cahaba Valley Coal Co., Birmingham, Ala.

County Coal Co. of Ala. Inc., 1 to 3 East Main St. Carnegie, Penna.

Crescent Coal Co., Birmingham, Ala. Seloca Nos. 2 and 7.

Dorman Coal Co., Birmingham, Ala. Dorman mine.

Henry Ellen Coal Co., Birmingham, Ala.

Montgomery Black Creek Coal Co., Warrior, Ala.

Morris Coal Co., Morris, Ala.

Piedmont Coal Mining Co., Birmingham, Ala.

Rogers-Talty Coal Co., Warrior, Ala. Pritchett Mine.

Shades Valley Coal Co., Birmingham, Ala. Winston mine.

Stockton Coal Co., North Birmingham, Ala.

Warrior Pratt Coal Co., Birmingham, Ala. Porter mine.

Weller Coal Co., Birmingham, Ala.

MARION COUNTY

Brilliant Coal Co., Birmingham, Ala. Brilliant mine.

Turner Mining Co., Brilliant, Ala. Turner mine.

ST. CLAIR COUNTY

Alabama Fuel & Iron Co., Birmingham, Ala. Acmar No. 1, 2, 3; Margaret 1, 2, 3, 5, New Acton.

Ragland Coal Co., Ragland, Ala. Coal City mine.

SHELBY COUNTY

Montevallo Mining Co., Birmingham, Ala. Aldrich mine.

Southern Coal & Coke Co., Boothton, Ala. Boothton mine.

Brookside Pratt Mining Co., Birmingham, Ala. Coalmont mine.

Little Gem Coal Co., Birmingham, Ala. Dogwood mine.

Eureka Coal Co., Birmingham, Ala. Eureka No. 2, 3 and 4.

West Helena Coal Co., Sicard, Ala. Sicard mine.

Montevallo Straven Coal Co., Straven, Ala. Straven mine.

Alabama Fuel & Iron Co., Birmingham, Ala. Acton Nos. 2 and 5.

Helena-Straven Coal Co., Straven, Ala.

Premier Coal Co., Helena, Ala.

Paramount Coal Co., Helena, Ala.

Shelby Coal Co., Birmingham, Ala. Superior mine.

Shelby Cahaba Coal Corp., Birmingham, Ala

Wadsworth Mining Co., Butler mine.

TUSCALOOSA COUNTY

Aetna Coal Co., Birmingham, Ala. Aetna mine.

The Alabama Co., Birmingham, Ala. Brookwood and Searles mines.

Big Sandy Iron and Steel Co., Coaling, Ala. Cedar Grove mine.

Cannon Shepherd Coal Co., Tuscaloosa, Ala. Gilmore mine.

Central Coal & Iron Co., Holt, Ala. Kellerman mine.

Liberty Coal Co., Birmingham, Ala. Liberty mine.

Riverview Coal Co., Tuscaloosa, Ala. Mabel mine.

Davis Creek Coal and Coke Co., Rock Castle, Ala. Rock Castle No. 3 mine.

Daniels Creek Coal Co., Birmingham, Ala. Woodrow mine.

Yolande Coal & Coke Co., Birmingham, Ala. Yolande No. 3 mine.

Boyd Bros., Peterman, Ala.

Henderson Land & Lumber Co., Tuscaloosa, Ala.

Warrior View Coal Co., Tidewater mine.

J. M. Maxwell, Maxwell mine.

WALKER COUNTY

Bertha Coal Co., Parrish, Ala. Bertha mine.

Annie Mae Coal Co., Corona, Ala. Annie Mae mine.

Farmers Coal Co., Fayette, Ala. Atlas mine.

Atlas Mining Co., Oakman, Ala. Atlas No. 2.

Dixie-Pratt Coal Mining Co., Oakman, Ala. Atlas No. 4.

Bankhead Coal Co., Jasper, Ala. Bankhead mine.

Barney Coal Co., Cordova, Ala. Barney mine.

Benoit Coal Mining Co., Benoit, Ala. Benoit mine.

Parrish Coal Co., Parrish, Ala. Blanton No. 2.

Stith Coal Co., America, Ala. Stith mine.

Borden Coal Co., Cordova, Ala. Borden mine.

Boyce Coal Co., Cordova, Ala. Boyce mine.

Ensor & Ensor, Cordova, Ala. Brewer mine.

Burnwell Coal Mining Co., Burnwell, Ala. Burnwell mine.

Thomas Creek Coal Co., Carbon Hill, Ala. Bynom Nos. 1 and 2.

Brilliant Coal Co., Birmingham, Ala. Calumet mine.

Carbon Hill Consolidated Coal Co., Birmingham, Ala. Carbon Hill mine.

Kershaw and Co., Birmingham, Ala. Cedron and Dora mines.

Charlotte Coal Co., Oakman, Ala. Charlotte mine.

S. J. Childers & Sons, Jasper, Ala. Childers mine.

Pratt Consolidated Coal Co., Birmingham, Ala. Clipper, Dora No. 10, Gamble, Gamma, Ruby, and Wegra.

Corona Coal Co., Birmingham, Ala. Corona Nos. 10, 11, 12, 13.

Shackleford Coal Mining Co., Nauvoo, Ala. Davis mine.

Sipsey Coal Mining Co., Empire, Ala. Dilworth mine.

Doliske Coal Co., Dora, Ala. Doliske mine.

Dora Fuel Co., Dora, Ala. Dora Fuel mine.

Dorman Coal Co., Inc., Birmingham, Ala. Dorman mine.

Sloss Sheffield Steel and Iron Co., Birmingham, Ala. Ivy mine.

Elliott Coal Co., Dora, Ala. Eliott mine.

Empire Coal Co., Birmingham, Ala. Empire Nos. 1 and 3.

Galloway Coal Co., Memphis, Tenn. Galloway Nos. 10, 11, 13, 15, and at Carbon Hill, Alabama.

Corry Coal Mining Co., Oakman, Ala. Gaslight mine.

Parrish Coal Co., Parrish, Ala. Gayosa mine No. 1.
Glover Coal Co., Dora, Ala. Glover mine.
Cordova Warrior Coal Co., Grays Shaft mine.
Guy V. O'Rear, Carbon Hill, Ala. Hynd mine.
Indian Head Mills of Alabama, Cordova, Ala. Indian Head mine.
Jagger Coal Co., Birmingham, Ala. Jagger No. 1.
Carbon Coal Co., Birmingham, Ala. Jagger No. 3.
Townley Coal Co., Townley, Ala. Lang mine.
Mount Carmel Co., Cordova, Ala. Mount Carmel mine.
Black Creek Coal Co., Nauvoo, Ala. Nauvoo No. 1 and 2.
Oakman Mining Co., Oakman, Ala. Oakman mine.
Guy V. O'Rear, Jasper, Ala. O'Rear mine.
Railway Fuel Co., Parrish, Ala. Parrish mine.
DeBardeleben Coal Co., Inc., Birmingham, Ala. Paynes Bend, Sipsey, and Borden mines.
Boyer Coal Co., Parrish, Ala. Pennsylvania mine.
Phillips Coal Co., Gamble, Ala. Phillips mine.
Piedmont Coal Co., Birmingham, Ala. Piedmont mine.
Consolidated Opr. & Eng. Co., Birmingham, Ala. Pocahontas mine.
Powell and Adair, Dora, Ala. Powell mine.
Pratt Fuel Co., Dora, Ala. Pratt Fuel mine.
Dinsey Coal Co., Cordova, Ala. Red Oak mine.
Nelson Coal Corp., Birmingham, Ala. Red Star mine.
Gulf States Portland Cement Co., Cordova, Ala. Riverside mine.
Royal Coal Corp., Birmingham, Ala. Royal mine.
Burnwell Mining Co., Birmingham, Ala. Samoset and Burnwell mines.
Louise Coal Co., Parrish, Ala. Louise mines.
Saragossa Mining Co., Saragossa, Ala. Saragossa mine.
Sartin Coal Co., Parrish, Ala. Borden mine.
American Mining Co., America, Ala. Standard mine.
Monro-Warrior Coal & Coke Co., Birmingham, Ala. Stirling mine.
Sulphur Springs Coal Co., Cordova, Ala. Sulphur Springs mine.
Summit Coal Co., Dora, Ala. Summit mine.
Supreme Mining Co., Birmingham, Ala. Supreme mine.
Export Coal Co., Empire, Ala. Town Creek mine.
Brookside-Pratt Mining Co., Birmingham, Ala. Warrior River mine.
Winona Coal Co., Gorgas, Ala. Winona mine.
Cedron Coal Mining Co., Townley, Ala.
Daylight Coal Mining Co., Jasper, Ala.
I. O. Drewrey Contracting Co., Jasper, Ala. Sunlight mine.
Goodwin Coal Co., Dora, Ala. Rabbit Head mine.
Manchester Coal Co., Manchester, Ala.
Mary Lee Coal Mining Co., Saragossa, Ala.
Mill Creek Coal Co., Carbon Hill, Ala.
Olive Coal Co., Oakman, Ala. Johnson mine.
Pratt Warrior Coal Co., Quinton, Ala.
J. W. Self Coal Co., Carbon Hill, Ala. Self mine.
Sorrelle Coal Co., Dora, Ala. ......
H. A. Todhunter, Cordova, Ala.
Wabash Coal Mining Co., Oakman, Ala. Gravlee No. 1.
West Alabama Coal Co., Jasper, Ala. Gayosa mine.

WINSTON COUNTY.

L. L. Dodd, Lynn, Ala.

Gamble Bros., Delmar, Ala. Mascot mine.

Glen Mary Coal Co., P. O. Box 625, Birmingham, Ala. Glen Mary mine.

Monro-Warrior Coal & Coke Co., Birmingham, Ala. Iceberg mine.

M. J. & J. D. Nailen, Delmar, Ala.

Shanks Coal Co., Natural Bridge, Ala. Shanks mine.

J. M. Thomason, Natural Bridge, Ala. Beulah mine.

Forrest Coal Co., Glen Mary, Ala.

T. P. Weaver, Delmar, Ala.

Robbins Coal Co., Chinquapin mine.

COKE.

Introduction.

THE outstanding feature of the coke industry in 1922 was the continued substitution of by-product coke for beehive coke and the remarkable fact that, despite the coal strike, the production of by-product coke increased nearly 45 per cent over that of 1921 and large accumulations of coke in stock were wiped out. After the strike was settled and improvement in transportation began the beehive-coke industry made a remarkable recovery and toward the end of the year was producing at about the rate established during the active year 1920; but the total production in 1922 was less than in any other year since 1887 except 1921.

Coke in Alabama

Alabama ranks fourth in the production of coke in the United States, exceeded only by Pennsylvania, Ohio, and Indiana in the order named.

The daily capacity of coke ovens in the State is 24,379 tons, of which nearly 50 per cent is of the beehive type. It is therefore interesting to note that 92 per cent of the coke produced in 1922 was made in by-product ovens.

The bulk of the coke produced was used in the blast furnaces of the State. Small quantities were used for foundry, domestic and other industrial uses.

Production and Consumption.

In 1922 the output of by-product coke was 3,493,656 tons and that of beehive coke was 306,209. Contrasted with 1921 these figures show an increase of 45.4 per cent for by-product and 131 per cent for beehive production. These figures are significant of the revival of business after the slump of 1921, especially the figures for beehive production. The fluctuations in by-product production are not so indicative due to economic

reasons, other than the sale of coke, which govern their operation.

Of the total amount of coal used in the manufacture of coke in Alabama 96 per cent was washed before it was charged to the ovens.

Statistics of the manufacture of coke in Alabama, 1880-1922

YEAR	Establishments	OVENS		Coal used (short tons)	Yield of coal in coke (per cent)	Coke produced (short tons)	Total value of coke at ovens	Value of coke at ovens, per ton
		Built	Building					
1880	4	316	100	106,283	57.0	60,781	$ 183,063	$3.01
1890	20	4,805	371	1,809,964	59.0	1,072,942	2,589,447	2.41
1900	30	6,529	690	3,582,547	58.9	2,110,837	5,629,423	2.67
1910	43	10,132	340	5,272,322	61.6	3,249,027	9,165,821	2.82
1915	38	9,318	0	4,695,938	65.4	3,071,811	8,545,555	2.78
1916	.....	*9,549	97	6,794,100	57.9	4,298,417	15,019,137	3.45
1917	.....	9,660	0	7,638,841	63.9	4,892,583	28,394,272	5.80
1918	.....	9,433	324	6,827,826	64.0	4,352,172	30,813,378	7.03
1919	.....	9,034	247	5,170,878	64.0	3,554,786	19,175,176	6.64
1920	.....	9,563	90	6,031,034	64.3	4,221,427	35,645,459	8.46
1921	.....	7,558	30	3,700,042	68.4	2,534,039	12,256,085	4.90
1922	.....	*7,656	30	5,625,642	67.5	3,799,865	14,708,245	3.86

*Includes 420 Semet-Solvay, 716 Koppers, and 60 Wilputte ovens.

Comparison of the production and value of coke in 1921-1922

YEAR	Number of ovens	Coal charged (short tons)	Coke produced (short tons)	Total value of coke at ovens
1921	7,558	3,700,042	2,534,039	$12,256,085
1922	7,656	5,625,642	3,799,865	14,708,245
Increase (1922)	98	1,925,600	1,265,826	2,452,160
Percentage	1.29	52.0	50.0	20.0

Table showing increase or decrease of 1922 over 1921

YEAR	Beehive coke: Active ovens	Beehive coke: Coal used (net tons)	Beehive coke: Coke produced (net tons)	Beehive coke: Value of coke at ovens —in dollars	By-product coke: Active ovens	By-product coke: Coal used (net tons)	By-product coke: Coke produced (net tons)	By-product coke: Value of coke at ovens —in dollars	Total: Coal used (net tons)	Total: Coke produced (net tons)	Total: Value of coke at ovens —in dollars
1921	6,417	223,119	132,912	*$ 794,314	1,141	3,476,923	2,401,127	*$11,461,771	3,700,042	2,534,039	$12,256,085
1922	6,460	509,661	306,209	* 1,735,406	1,196	5,115,981	3,493,656	* 12,972,839	5,625,642	3,799,865	14,708,245
Increase (1922)	53	286,542	173,297	$ 940,092	55	1,639,058	1,092,529	$ 1,511,068	1,925,600	1,265,826	$ 2,452,160
Percentage	....	128.1	131.0	118.5	....	47.2	45.4	13.2	52.0	50.0	20.0

*Values do not include breeze and screenings.

Coke produced in beehive and by-product coke ovens in Alabama, 1920, 1921 and 1922

	Bee-hive coke: Active ovens.	Bee-hive coke: Coal used (net tons)	Bee-hive coke: Average yield (per cent).	Bee-hive coke: Coke produced (net tons)	Bee-hive coke: Value of coke at ovens.	By-product coke: Active ovens.	By-product coke: Coal used (net tons)	By-product coke: Average yield (per cent).	By-product coke: Coke produced (net tons)	By-product coke: Value of coke at ovens.	Total: Coal used (net tons)	Total: Coke produced (net tons)	Total: Value of coke at ovens.
1920	....	1,488,755	59.8	1,890,690	*$ 9,300,510	1,081	4,542,279	68.8	3,330,737	*$25,959,526	6,031,034	4,221,427	$35,645,459
1921	6,417	223,119	59.6	132,912	*$ 794,314	1,141	3,476,923	73.5	2,401,127	*$11,461,771	3,700,042	2,534,039	$12,256,085
1922	6,460	509,661	61.6	306,209	*$ 1,735,406	1,196	5,115,981	72.1	3,493,656	*$12,972,839	5,625,642	3,799,865	$14,708,245

*Values do not include value of screenings and breeze.

Average value per short ton and percentage of coke from coal in Alabama 1913-1922

	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922
Average value	$2.90	$2.73	$2.78	$3.49	$5.80	$7.08	$6.64	$8.46	$4.90	$3.86
Percentage yield	63.6	65.9	65.4	63.3	63.9	64.00	64.00	64.3	68.4	67.5

Quantity (net tons) and value of coke produced in Alabama, 1917-1922

	1917	1918	1919	1920	1921	1922	Increase 1922	Percentage Increase
Quantity	4,892,589	4,352,172	3,554,786	4,221,427	2,534,039	3,799,865	1,265,826	50.0
Value	$28,394,272	$30,813,378	$19,175,561	$35,645,459	$12,256,085	$14,708,245	$2,452,160	20.0

Quantity and value of the coal used in the manufacture of coke in 1920, 1921, and 1922, and quantity and value of same per ton of coke.

YEAR	Coal used (short tons)	Total value of coal	Value of coal per ton	Quantity of coke per ton of coal (short tons)	Quantity of coal to a ton of coke
1920	6,031,034	$23,903,853	$3.96	1,286	3,108
1921	3,700,042	12,149,816	3.26	1,378	2,930
1922	5,625,642	13,936,937	2.47	1,351	2,960

COKE OVENS.

Coke ovens in Alabama at the end of 1912-1922.

YEAR	Beehive	By-product
1912	9,588	620
1913	9,584	700
1914	8,568	750
1915	8,568	750
1916	8,806	743
1917	8,813	847
1918	8,586	847
1919	8,734	1,009
1920	8,432	1,081
1921	6,417	1,141
1922	6,460	1,196

Record of by-product ovens in Alabama, 1910-1922.

YEAR	Built	Building
December 31, 1910	280	340
December 31, 1911	340	280
December 31, 1912	620	100
December 31, 1913	700	20
December 31, 1914	750	0
December 31, 1915	750	0
December 31, 1916	743	97
December 31, 1917	847	0
December 31, 1918	847	324
December 31, 1919	1,009	247
December 31, 1920	1,081	90
December 31, 1921	1,141	30
December 31, 1922	1,196	30

BEEHIVE COKE PRODUCERS, 1922

The Republic Iron & Steel Co., Republic Bldg., Youngstown, Ohio. Works at Thomas and Warner, Jefferson County, Alabama.

U. S. Cast Iron Pipe & Foundry Co., Bessemer, Ala. Works at Bessemer, Jefferson County, Ala.

The Alabama Co., Birmingham, Ala. Works at Brookwood, Tuscaloosa County, Ala.

Yolande Coal & Coke Co., Birmingham, Ala. Works at Yolande and New Connellsville, Tuscaloosa County, Ala.

BY-PRODUCT COKE PRODUCERS

Gulf States Steel Co., Brown-Marx Bldg., Birmingham, Ala. Works at Alabama City, Etowah County, Alabama.

Semet Solvay Co., Syracuse, N. Y. Works at Ensley, Jefferson County, and Tuscaloosa, Tuscaloosa County, Alabama.

Tennessee Coal, Iron & R. R. Co., Birmingham, Ala. Works at Fairfield, Jefferson County, Alabama.

Woodward Iron Co., Woodward, Ala. Works at Woodward, Jefferson County, Alabama.

Sloss-Sheffield Steel and Iron Co., Hugh Morrow, Vice-Pres., Birmingham, Ala.

Alabama By-Products Corporation, Birmingham, Ala.

FULLERS EARTH.

IN 1922, a small quantity of Fuller's earth was produced in DeKalb County. The production was small and of little importance, but the state ranked fourth among the producing states for the year.

Fuller's earth obtains its name from its original use in fulling cloth, but only a small quantity, mainly domestic, is now used in this country, for this purpose. It is used principally in bleaching and in clarifying or filtering fats, greases, and oils. It is also used in the manufacture of pigments for printing wall papers; in detecting certain coloring matters in some food products; as a substitute for talcum powder, and in medicine, as a poltice and as an antidote for alkaloid poisons. There were less than three producers in the State, so no statistics of the production can be given.

PRODUCTION.

Fuller's earth produced and marketed in the United States, 1916-1922

Year	Operators reporting sales	Short tons	Value at mines	
			Total	Average
1916	10	67,822	$706,951	$10.42
1917	11	72,567	772,087	10.64
1918	14	84,468	1,146,354	13.57
1919	10	106,145	1,998,829	18.83
1920	12	128,487	2,506,189	19.51
1921	12	105,609	1,973,848	18.69
1922	15	138,944	2,289,719	16.48

IMPORTS.

The imports of Fuller's earth, which at one time constituted the entire supply, were increasing before the war and reached their maximum in 1914. During the war imports naturally decreased. Immediately after the war they increased but did not reach the pre-war record, and in 1921 they made a sudden

drop, reaching the lowest quantity since 1900. In 1922 the imports increased slightly in quantity (8 per cent) but were, except for those of 1921, the smallest since 1904. Owing, however, to the higher prices obtained in later years the value of the imports in 1922 at the principal markets of the countries of export was not so low comparatively and was greater than that of any year prior to 1911. Wrought or manufactured earth represents about 95 per cent of the quantity and value of imports.

Fuller's earth imported and entered for consumption in the United States, 1917-1922

Year	Unwrought or unmanufactured			Wrought or manufactured			Total		
	Short tons	Value		Short tons	Value		Short tons	Value	
		Total	Average		Total	Average		Total	Average
1917	1,441	$11,718	$ 8.13	15,553	$164,699	$10.58	16,994	$176,417	$10.38
1918	*1,085	*12,636	*11.65	*15,837	*213,599	*13.49	*16,922	*226,235	*13.37
1919	373	4,301	11.53	13,500	185,410	13.73	13,873	189,711	13.67
1920	*1,518	19,793	*13.04	17,497	202,100	11.55	*19,015	221,893	*11.67
1921	483	6,172	12.78	9,261	113,243	12.23	9,744	119,415	12.26
1922	607	7.413	12.21	9,962	128,282	12.88	10,569	135,695	12.84

*Revised figures.

FULLER'S EARTH PRODUCERS IN 1922

Ladd Fuller's Earth Co., Fort Payne, Alabama. Mine near Fort Payne, DeKalb County, Alabama.

GRAPHITE.

By Arthur H. Redfield

Introduction.

THE peculiar physical properties of graphite—infusibility, chemical inertness, high conductivity, extreme softness, and low specific gravity—fit it for many uses, such as the manufacture of crucibles and other refractory products, lubricants, lead pencils, paint, foundry facings, as a preparation to loosen boiler scale, as polish for gun-powder, and for various applications in electrical works.

Natural graphite may be either crystalline or amorphous. The term crystalline or flake graphite is commonly understood to mean graphite in crystals large enough to be visible to the naked eye; much of the so-called amorphous graphite shows a crystalline structure under the microscope. Crystalline graphite occurs either in veins, as in the Ceylon deposits, or as flakes disseminated through the country rock, as in most of the crystalline graphite deposits of the United States. Most deposits of amorphous graphite are the result of the alteration of coal beds by the intrusion of igneous rocks. Amorphous graphite is also made artificially by means of the electric furnace.

Uses of Graphite.

By far the most important use of graphite is in the manufacture of crucibles, and for this reason graphite is a mineral resource of vital importance in time of war. The makers of crucibles have also greatly increased their production during the last two years. Graphite for making crucibles must be of great purity. Its content of graphitic carbon should exceed 85 per cent. and should preferably be as high as 90 per cent., and it must be practically free from mica, pyrite, and iron oxide. A small amount of quartz is not injurious. Graphite for making crucibles should also be coarse enough for the interlocking fragments to be easily bound together by the clay

with which it is mixed. It should preferably contain a large proportion of flakes about 1 millimeter in diameter and should all remain on a 100-mesh sieve.

Most makers of crucibles prefer to use Ceylon graphite mixed with 10 to 25 per cent American flake in part because the more nearly cubical fragments of Ceylon graphite have a much smaller surface area in proportion to their volume than the thin flakes of the domestic graphite and hence require proportionately less clay as a binder. Ceylon graphite is also morely nearly free from undesirable impurities such as mica and pyrite. It is possible, however, to use domestic flake graphite alone with good success in crucible manufacture. In recent commercial tests of crucibles made with Alabama flake graphite and domestic clay three No. 80 crucibles, tested in copper melting, gave 21 heats each, and a fourth 42 heats. There is, however, no immediate prospect of a sufficiently increased domestic production to supply the needs of crucible manufacturers, and graphite must still be imported from Ceylon or Madagascar, but it is believed that the percentage of domestic material used could be increased. The only American graphite resembling the Ceylon material is produced in small amount in Montana.

The difficulties encountered since 1914 in finding satisfactory supplies of clay have now been largely overcome, and the crucibles made with domestic clays are of much better grade than formerly. A part of the great demand for crucibles has been due to the fact that crucibles made with domestic clays did not stand as many heats as those made with the Bavarian clay and consequently a large number were required to accomplish the same work. According to McNaughton,* the results attained in the early attempts to use domestic clays were very unsatisfactory. In certain tests only 4 or 5 heats were secured with crucibles of average size, as against 25 to 30 heats before the war. At present from 15 to 25 heats is the range of average service. The cost of the domestic clay, however, is more than double that of the German clay used prior to the war.

Graphite for other uses does not require the same grade of material as for crucibles, and for most purposes amorphous

*McNaughton, M., The crucible situation: Metal Industry, vol. 15, pp. 431-432, 1917.

graphite can be used with as good effect as the crystalline variety. Graphite for foundry facings, commonly known as "silver lead," is of varying degrees of purity, according to the work required. Ceylon dust was formerly used to a considerable extent for this work, but the present high prices due to the high freight rates, have greatly decreased its use. Next to crucibles, foundry facings probably absorb more graphite than any other single use.

Lubricating graphite must be of a high degree of purity and absolutely free from gritty substances, such as quartz. As size of grain is not essential, either amorphous or crystalline graphite may be used.

For pencils either amorphous graphite alone or a blend of amorphous and fine-grained crystalline graphite is employed. The graphite is mixed with clay in varying proportions, according to the hardness desired. In order that the product shall be uniform, very pure graphite is required.

For other uses, such as fillers for dry batteries, facings for molds, polish for explosives, paints, boiler mixture, and many similar requirements, either crystalline or amorphous graphite may be used, and the degree of purity essential varies according to the nature of the use.

Alabama, General Features.

PRODUCTION.

During the war Alabama was the leading state in the production of graphite but the cessation of hostilities caused a slackening of production until in 1921 but a few tons were produced. During 1922 three companies have again entered the field with the result that Alabama ranks second in production. Crystalline graphite totaling 577,940 pounds was produced valued at $25,777.

The present operators are using improved milling methods which were installed during the high prices of 1918. Alabama milling practice has been described in detail in a recent publication of the Bureau of Mines. At present the average recovery from the Alabama ores, which contains 2½% of graphite, is about 19 pounds of No. 1 flake, 5 pounds of No. 2 flake, and 3 pounds of dust per ton of ore.

The Alabama flake graphite from different mines varies greatly in purity, and lack of standardization hinders the full development of the deposits. A few companies produce a No. 1 flake containing 90 per cent carbon, others maintain an 85 per cent standard, and some market flake averaging only about 80 per cent.

The following analyses, furnished through the courtesy of one company, show the content of the average grade of the Alabama product. No. 1 represents samples from five tons and No. 2 from three tons of flake.

Analyses of Alabama flake graphite.

	1	2
Volatile matter	2.00	1.08
Carbon (graphitic)	84.00	84.72
Ash	14.00	14.20
	100.00	100.00
Iron	.97	———
Sulphur	.08	———

Ash analysis of sample 2.

	Ash	Percentage for entire product
Fe_2O_3	8.32	1.18
Al_2O_3	22.94	3.26
SiO_2	64.27	9.13
CaO	Trace	Trace
MgO	1.43	.20
S	.32	.05
Alkalies	2.78	.39
	100.06	14.21

The ash analysis indicates that the principal foreign impurity in the finished product is silica, with a little clayey matter, very little mica, and almost no pyrite.

The graphite occurs in a graphitic schist which forms lenses in a series of metamorphic rocks traversing parts of Clay, Coosa and Chilton counties. Quartz is the principal constituent of the graphite-bearing schist, with subordinate amounts

of pyrite, mica (biotite), and apatite. These bands of schist rarely exceed 100 feet in thickness and appear to be fairly continuous, though prospecting has not yet proceeded sufficiently to establish their continuity over long distances. The average graphite content of the ore in terms of graphitic carbon is 3 or 4 per cent, though in some places analyses show a carbon content of 5 or 6 per cent. In nearly every deposit the graphite schist is intruded by small stringers of pegmatitic granite. These contain only a little graphite, but appear to have caused a more intense recrystallization of the original carbon in the intruded rock, which has resulted in a coarsening of the flake in the immediate vicinity and possibly in an actual enrichment in the graphite content. The wall rocks are in most places schists that are similar in type to the graphite-bearing schist but contain less graphite and more mica. At a few localities, however, one wall consists of hornblende schist, probably an altered basic intrusive. No graphite is found where the hornblende schist is intruded by granite—an evidence that the carbon from which the graphite is derived is not a product of the granite intrusion. The graphite schists commonly crop out along ridges, and, as a rule, the overburden is very light. The pyrite of the deposits is in most places completely oxidized to the depth of 50 to 60 feet. Besides removing this very objectionable constituent of the ore, weathering has softened the rock and lessened the coherence between the graphite and the other minerals, which facilitates both mining and concentration. The unoxidized schist is avoided as far as possible in mining operations, as it is hard to crush, and the pyrite can be completely eliminated from it only with difficulty. It would, however, be perfectly feasible to treat this "blue rock" should necessity arise.

The following recent articles are of interest in regard to the graphite deposits of Alabama.

Prouty, W. F., Flake graphite in Alabama; its location, its history, and its value to the State: Birmingham Age-Herald, January 28, 1917.

——— Extent and development of flake graphite resources of Alabama: Manufacturers' Rec., April 19, 1917, pp. 66-67.

——— Geology and mineral resources of Clay County, with special reference to the graphite industry. Geol. Surv. Ala., County Report No. 1. 1923.

Pratt, J. H., Alabama graphite deposits: Manufacturers' Rec., March 22, 1917, p. 58.

Herr, Irving, Clay County graphite district of Alabama: Eng. and Min. Jour., vol. 103, pp. 693-697, April 21, 1917.

GRAPHITE PRODUCERS IN 1922

Flaketown Graphite Co., Mountain Creek, Alabama.
Pocahontas Graphite Co., Ashland, Alabama.
Ceylon Graphite Co., Hollins, Alabama. Office, Birmingham, Ala.

GRAPHITE INDUSTRY.

PRODUCTION.

NATURAL GRAPHITE.

The sales of domestic graphite in the United States in 1922 showed an increase of 28 per cent in quantity, but the mining of graphite still showed the effects of the postwar depression, though there was a small gain in production after the new tariff law went into effect, September 22, 1922. This law imposed a duty of 10 per cent ad valorem on amorphous graphite, of 20 per cent ad valorem on crystalline lump, chip, or dust, and of 1½ cents a pound on crystalline flake. Imports increased from 8,183 short tons in 1921 to 12,606 short tons in 1922.

Domestic natural graphite sold in the United States, 1918-1922

Year	Amorphous		Crystalline	
	Short tons	Value	Pounds	Value
1918	6,560	69,455	12,861,839	1,454,799
1919	3,379	47,716	8,086,191	731,141
1920	4,694	49,758	9,632,360	576,444
1921	1,842	20,860	1,189,523	75,664
1922	2,200	*	1,849,766	85,242

*Value may not be published.

Number of operators reporting production of graphite, 1918-1922

State	1918	1919	1920	1921	1922
Alabama	25	10	7	2	3
California	1	1	1	1	1
Colorado	1	1	1	1	
Montana	1		1		
Nevada	1	1	1	1	1
New York	3	2	2	1	
Pennsylvania	6	3	1		
Rhode Island	2	1	2	1	1
Texas	2	1	1	1	1
	42	20	17	8	7

*Statistics relating to domestic production prepared by L. M. Beach; those relating to foreign production compiled by W. I. Whiteside.

The sales of crystalline graphite in 1922 showed an increase of 56 per cent in quantity and 13 per cent in value, as compared with 1921. This graphite was produced by only five firms operating in three States, and therefore State totals may not be published. Texas was the leading producer, Alabama ranked second, and California third.

The proportion of the available supply represented by the domestic output is shown in the following table:

Available supply of crystalline graphite in the United States, 1918-1922

	1918	1919	1920	1921	1922
Short tons					
Domestic production	6,431	4,043	4,816	595	925
Imports:					
Ceylon	9,029	9,451	9,204	2,311	7,258
Madagascar	970	10,016	4,710	1,078	1,305
Other countries	3,314	1,505	2,200	687	641
	13,313	20,972	16,114	4,076	9,204
Total available supply	19,744	25,015	20,930	4,671	10,129
Percentage represented by domestic production	32.6	16.2	23.0	12.7	9.13
Value					
Domestic production	$1,454,799	$731,141	$576,444	$75,664	$85,242
Imports:					
Ceylon	2,397,735	1,530,281	1,077,290	199,440	332,195
Madagascar	265,338	1,205,350	286,383	67,509	52,275
Other countries	270,136	102,390	159,517	48,035	24,669
	2,933,209	2,838,021	1,523,190	314,984	409,139
Total available supply	4,388,008	3,569,162	2,099,634	390,648	494,381
Percentage represented by domestic production	33.2	20.5	27.5	19.4	17.24

Eight of the 13 firms that reported sales of crystalline graphite in 1920 stated that their mines were idle in 1922. The active firms were as follows:

Ceylon Graphite Co., Birmingham, Ala.
Flaketown Graphite Co., Mountain Creek, Ala.
California Graphite Co., Los Angeles, Calif.
Pocahontas Graphite Co., Ashland, Ala.
Southwestern Graphite Co., Boston, Mass. (operating in Texas).

In 1922 the quantity of amorphous graphite sold increased 19 per cent. The supply was furnished by the Graphite Mines Corporation, New York, N. Y., operating in Rhode Island, and the Carson Black Lead Co., Oakland, Calif., operating at Carson, Nev.

MANUFACTURED GRAPHITE.

Graphite is manufactured by the Acheson Graphite Co., at Niagara Falls, N. Y. The figures given below, published by permission of this company, represent only the manufactured graphite that comes into competition with natural graphite.

Graphite manufactured by the Acheson Graphite Co., 1917-1922, *in pounds*

1917	10,474,649	1920	7,399,749
1918	9,182,272	1921	5,888,000
1919	8,163,177	1922	13,031,926

IMPORTS AND EXPORTS.*

The reports of the Bureau of Foreign and Domestic Commerce as to imports show only the country shipping the goods, which is not invariably the country of origin. For example, the graphite entered in that bureau's statements as imported from France probably originated in Madagascar, and that imported from Great Britain should probably be credited to Ceylon and possibly in part to Madagascar. The shipments from Japan probably consisted of graphite from Chosen [Korea]. In this chapter the graphite imported from the United Kingdom has been arbitrarily credited to Ceylon, that imported from France to Madagascar, and that imported from Japan to Chosen. Imports of more doubtful origin are included under "Other countries."

*The figures showing imports and exports were compiled by J. A. Dorsey of the United States Geological Survey from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Graphite imported into the United States, 1916-1922

(General imports)

Country of origin	1916	1917	1918	1919	1920	1921	1922
Short tons							
Ceylon	26,232	24,575	9,029	9,451	9,204	2,311	7,258
Madagascar	1,631	4,393	970	10,016	4,710	1,078	1,305
Canada	4,127	3,476	3,084	1,504	2,170	687	533
Brazil	1	18	45				
Mexico	5,331	7,570	5,600	5,506	3,659	3,404	2,197
Chosen (Korea)	5,375	2,462	568	126	810	646	1,170
Italy	151	115	17	22	137	47	35
Austria					58		
Germany					30		6
Other countries	169		185	1	317	10	102
	43,017	42,609	19,498	26,626	21,095	8,183	12,606
Value							
Ceylon	$6,356,532	$7,179,208	$2,397,735	$1,530,281	$1,077,290	$199,440	$332,195
Madagascar	241,863	1,057,081	265,338	1,205,350	286,383	67,509	52,275
Canada	314,177	349,034	236,226	102,163	157,015	48,035	17,392
Brazil	75	4,380	7,351				
Mexico	238,000	285,568	134,183	135,464	131,832	120,153	40,954
Chosen (Korea)	103,619	83,558	24,455	3,948	29,936	15,145	29,819
Italy	4,133	3,092	628	663	5,072	1,019	1,045
Austria					1,195		
Germany					2,502		425
Other countries	21,484	67	26,559	227	20,087	775	6,856
	7,279,883	8,961,988	3,092,475	2,978,096	1,711,312	452,076	480,961

Graphite imported for consumption in the United States, 1913-1922

Year	Short tons	Value	Year	Short tons	Value
1913	28,879	$2,109,791	1918	19,498	$3,092,475
1914	21,990	1,398,209	1919	26,626	2,978,096
1915	23,075	2,241,163	1920	21,095	1,711,312
1916	42,930	7,279,883	1921	8,183	452,076
1917	42,577	8,961,988	1922	12,606	480,961

In 1922 the imports of crystalline graphite increased 126 per cent in comparison with 1921; this gain far outstripped the increase of 56 per cent in domestic production.

The quantity of graphite annually exported from the United States is very small. In 1922 there was a decrease of 38 per

cent in the quantity of unmanufactured graphite exported, but the value decreased only 19 per cent, increasing from 5.29 to 6.86 cents a pound. The manufactured graphite exported showed a decrease of 62 per cent in value.

Graphite exported from the United States, 1917-1922.

YEAR	Unmanufactured graphite		Manufactures of graphite
	Quantity (pounds)	Value	
1917	5,146,816	$349,563	$891,687
1918	1,907,719	121,555	731,518
1919	1,258,040	90,185	788,755
1920	1,213,616	112,771	610,261
1921	1,841,578	95,998	679,369
1922	1,138,708	78,094	*255,019

*Except crucibles, lead pencils and pencil leads.

The exports of lead pencils and pencil leads and of crucibles are not included in the tables showing articles of manufactured graphite but are given separately. The value of the pencils and leads exported in 1922 was $1,659,201, or 20 per cent less than the corresponding value in 1921, which was $2,074,508. Crucibles to the number of 355,155, valued at $92,273, were exported in 1922. In this number were included, however, both graphite crucibles and an unknown number of clay crucibles of low price.

PRICES.

In 1922 the price of domestic flake graphite ranged from 4 to 5 cents a pound; in 1921 from 2 to 13 cents. The average price of domestic flake at the mines in 1922 was 4.6 cents, which was 1.8 cents less than 1921.

The accompanying table is based on information furnished by importers prior to 1920. The figures for 1920, 1921, and 1922 were furnished by Mr. Charles Pettinos, of New York. The low prices shown reflected the general depression of the graphite market in the United States.

Average prices of Ceylon graphite c. i. f. New York, 1914-1922

(Cents per pound)

Year	Lump		Chip		Dust		Remarks
	First grade	Second grade	First grade	Second grade	First grade	Second grade	
1914	6½- 9½	7½- 8½	7¼- 7¾	6½- 7	4¾- 5¼	3½- 4	Low, first half; high, second half.
1915	9⅝-20	8 -14	7 -14	6½-12	7½- 9½	6½- 9½	Do.
1916	20 -28	14 -21	13½-20	11½-17	9½-12	9½-10	Do.
1917	28 -32	21 -23	20 -23	17 -19	11 -13	10 -12	High level maintained throughout the year.
1918	28½-15¼	22 -14	21½-12½	18½-11	12 -10½	10 - 9	High, first half; low, second half.
1919	14 -15¼	12 -13	10 -11	8 - 9	6¾- 7½	5 - 6	Low throughout the year.
1920	14 - 9	11 - 7	10 - 7	7½- 5½	7 - 5	5 - 3½	High, first half; low, second half.
1921	5½- 6	4½- 5	4½- 5	3½- 4	3¼- 3¾	2 - 2½	Low throughout the year.
1922	5 - 6	4 - 4½	4¼- 3¾	3¾- 3¼	3 - 3½	2 - 2½	Do.

REVIEW OF WORLD'S GRAPHITE INDUSTRY.

Recovery from the depression of 1920 and 1921 marked the year 1922 in the mining of graphite. With but few exceptions all the producing countries increased their output of graphite, both crystalline and amorphous. The general revival of industry after the postwar depression of 1919 and 1920 in Europe has resulted in an increased demand for graphite crucibles, foundry facings, lubricants, lead pencils and other manufactures of graphite. The world's production has consequently risen from an estimated total of 87,167 metric tons in 1921 to an estimated total of 107,000 tons in 1922.

The world market is still depressed, however by the existence of large stocks of unsold graphite held by producers in Madagascar, in Ceylon, and in Alabama, as well as in the hands of German, French, British, and American dealers. These stocks represent for the most part an overproduction of graphite in 1917 and 1918 and an accumulation of unsold output of 1919, 1920, and 1921, when the demand for graphite fell below normal. These stocks, of which no exact totals are available, must be absorbed before the graphite industry of the world will be on a stable basis.

World's production of natural graphite, 1919-1922, in metric tons

	1919	1920	1921	1922
United States:†				
Amorphous	3,065	4,258	1,671	1,996
Crystalline	3,668	4,369	540	839
Canada†	1,234	1,987	850	‡590
Greenland	—	‖1,380	2,000	§
Mexico	4,023	2,992	2,911	*2,054
Brazil**	2	—	—	—
Austria	8,265	11,543	13,280	‖11,650
Czechoslovakia	31,234	22,925	‖20,000	‖22,000
Finland	30	27	§	§
France	650	272	§	§
Germany	30,525	20,639	*24,565	‖30,000
Italy	7,626	5,398	5,233	‡7,300
Norway	—	10	—	—
Spain	1,958	6,315	2,772	§
Sweden	—	7	—	§
British India	129	102	25	§
Ceylon**	6,779	9,353	4,419	11,023
French Indo-China**	7,451	—	—	—
Japan	1,954	1,133	*842	‖1,000
Chosen**	12,945	18,259	8,015	19,362
Madagascar	4,983	4,000	***	***
Union of South Africa	78	66	44	‖38
Australia	102	54	—	§
	126,701	115,089	‖87,167	‖110,000

†Shipments. ‡Preliminary. ‖Estimated. §No data. *Unofficial. **Exports. ***Negligible.

Graphite mining in Canada and in Mexico shared in the depression felt by the industry in the United States. No graphite was mined in Canada during 1922. The Black Donald mill, at Whitefish Lake, Ontario, was operated intermittently during the year and treated 1,700 tons of ore mined in 1921, and the Quebec Graphite Co. made some shipments from stock. Shipments from Mexico to the United States through Nogales, Ariz., during 1922, according to the Bureau of Foreign and Domestic Commerce, amounted to only 1,993 metric tons (1,962 long tons), as compared with 3,088 metric tons (3,039 long tons) in 1921 and 3,319 metric tons (3,267 long tons) in 1920.

In view of the lack of statistics of graphite production, conditions in Germany must be inferred rather than described. The German production of graphite in 1922 is estimated at 30,000 metric tons. In 1922, as in 1921, the depreciation of the mark in German exchange protected the Bavarian graphite

producer from any very strong competition from Ceylon or Madagascar graphite. For central Europe Germany is the principal market for graphite. German statistics of imports and exports of graphite and graphite products in 1922 indicate an increased consumption of graphite in Germany. This demand aided the production of raw graphite in Austria and Czechoslovakia, where the graphite industry depends rather on the German than on the domestic market. A rise in railroad rates in Austria placed the Austrian and Styrian producers at a disadvantage on the German market as compared with the Bohemian and Moravian producers, who are nearer at hand. This difference resulted in a decreased production in 1922 in Austria as contrasted with the increased production in Czechoslovakia.

The Ceylon graphite industry was revived by the increasing demand. A total of 216,999 hundredweight (11,023 metric tons) was exported from the island in 1922. About 64.6 per cent of the 1922 exports went to the United States, 10.15 per cent to the United Kingdom, 9 per cent to Germany, and 8.7 per cent to Japan. Stocks of graphite held in Ceylon on January 1, 1923, were estimated at 15,100 tons.

Exports from Chosen in 1922 increased markedly over those of 1921 and even surpassed those of 1920. They included 28,571 piculs (1,717 metric tons) of flake graphite and 293,596 piculs (17,645 metric tons) of amorphous graphite. About 95 per cent of these shipments went to Japan, to be for the most part manufactured or re-exported. A revival in the Japanese lead pencil industry, which consumes a large part of the Chosen graphite, is indicated by the increased exports of lead pencils from Japan during the first eleven months of 1922.

The situation in Madagascar shows no signs of improvement. Stocks held in the colony on January 1, 1922, were officially estimated at 18,000 to 20,000 metric tons, or at the same amount as at the beginning of 1921. Exports during 1922 amounted to 6,675 tons, as compared with 6,220 tons in 1921 and 4,425 tons in 1920. The exports in 1922 were almost entirely taken from old stocks. Shipments to Great Britain consisted chiefly of the purchases of a single crucible manufacturer; shipments to France and Germany were made on consignment. Little graphite was mined in the colony during 1922.

IRON ORE, PIG IRON, AND STEEL.

By Ernest F. Burchard, H. W. Davis
and Eugene A. Smith

GENERAL REVIEW.

AFTER the period of severe depression and great uncertainty in the iron industry that began in the autumn of 1920 and continued until late in 1921, conditions at the beginning of 1922 were still unsettled but appeared to have passed the crisis and to be once more improving. Prophesies made early in 1922 were conservative, indicating that a more active but subnormal demand for iron ore might be expected, and therefore there was no great disappointment when the total output of iron ore for the year proved to be less than 80 per cent of the averages for the preceding 5 and 10 year periods, but naturally there was considerable satisfaction in the increases of 60 per cent and 90 per cent, respectively, in production and shipments of ore as compared with 1921. The production of iron ore in 1922 ranked about with that of 1906. The output of pig iron increased 64 per cent as compared with 1921 and was equal to about 86 per cent of the average for the preceding 10-year period and about 84 per cent of the average for the preceding 5 years. The quantity corresponded closely with that manufactured in 1910 and was less than for most of the succeeding years.

The average price per ton for iron ore at the mines decreased about 7 per cent and that of pig iron at the blast furnaces about 9 per cent. Low prices for pig iron in the first three months of the year may have been a factor in stimulating trade. The quoted prices of ferromanganese, spiegeleisen, and steel showed nearly the same range as in 1921. Profits are generally considered to have been small notwithstanding the greater volume of business in 1922, and the quarterly reports of several steel companies showed deficits in the first nine months of the year.

No serious labor disturbances occurred directly in the iron mining or manufacturing fields, although, of course, the effects

of the strikes of the bituminous coal miners and the railway shopmen were keenly felt. In the Lake Superior iron-mining districts at the end of 1921 many mines that had been shut down on account of lack of demand were put into operation mainly in order to furnish employment to the needy miners. Wages were necessarily reduced, but in May, 1922, the wage scales of the latter part of 1921 were restored, and in September advances of 10 and 15 per cent were made. A shortage of mine labor began to be felt in September through the influence of increased industrial activity and restricted immigration. In the iron and steel industry labor shortage was felt early in the summer, and a general wage advance of 20 per cent was made early in the autumn as a means of checking the emigration of foreign-born workmen. A movement toward the abolition of the 12-hour day in the steel industry was made by the President of the United States at a conference with representative manufacturers in May and was followed by a serious effort on the part of the manufacturers to find ways and means to accomplish this end.

One feature of the year was a movement toward the consolidation of seven important steel-manufacturing companies, which terminated in the acquisition of certain of these companies by subsidiaries of the Bethlehem Steel Corporation, and the consequent entry by this concern into the Lake Superior iron-ore field. Heretofore the Bethlehem furnaces have depended largely on ores from Cuba, Chile, Sweden, and Spain, but for the recently acquired plants farther west Lake ores will be more of a necessity.

Buying of iron and steel was stimulated to some extent by the scarcity of stocks at the end of 1921, but the demand was not uniform during 1922, and only in the autumn was a large percentage of manufacturing capacity utilized. To building construction, which is regarded as having established a record for value in 1922, is to be ascribed one of the most sustained demands, and the railroads and automobile manufacturers were fairly heavy buyers. Demand for iron and steel for agricultural uses, for oil-well drilling, and for ship-building were relatively low. The coal strike, which lasted five months, naturally affected the situation greatly, retarding production and increasing prices, and the railroad shopmen's strike

seriously interfered with the movement of raw materials and finished products.

The total domestic output of pig iron probably required about 52 per cent of the apparent maximum capacity of the country, according to figures of the American Iron and Steel Institute, but this capacity was not utilized steadily, for at the beginning of 1922 there were only 125 furnaces in blast; on June 30 there were 201; and at the end of the year, 263. The production of steel ingots is considered to have utilized about 61 per cent of the manufacturing capacity, the output having ranged from less than 50 per cent of capacity in August to 80 per cent late in the year; a higher percentage was precluded by the restrictions of transportation facilities and labor supply. The pig-iron output of the United States represented more than one-half of the world's production and nearly twice that of all the principal producing countries of Europe combined. The production of these European countries increased only about 41 per cent, compared with the increase of 64 per cent in the United States. Decreases in export figures indicate that the United States is not contributing large quantities of iron and steel toward the rehabilitation of Europe, and increases in imports from war-stricken European countries indicate that their products are already invading American markets.

The tariff act of 1922 placed on the free list iron ore, including manganiferous iron ore, and the dross or residuum from burnt pyrites. On the dutiable list was placed iron in pigs, iron kentledge, spiegeleisen containing more than 1 percentum of carbon and less than 30 per cent of manganese, 75 cents per ton; wrought and cast scrap iron and scrap steel, valued at not more than 7 cents per pound, 75 cents per ton.

SOUTHEASTERN STATES.

The revival in iron-ore mining in the Birmingham, Chattanooga, and other districts in Alabama, Tennessee, North Carolina, and Georgia is shown in increases ranging between 74 and 127 per cent. No important changes in mining or discoveries of ore have been reported from any of these areas. Of interest in prospecting and mining are the publication by the Geological Survey of bulletins on magnetic ores in North Carolina and east Tennessee and on brown ore in North Carolina and the

continuation of field and laboratory studies begun by the Bureau of Mines in 1921 on iron ores and on mining and concentration of these deposits. Among these special studies was the use of the dip needle in magnetometric prospecting for deposits of brown ores. Studies of concentration of both brown and red ores are being carried on, and that of the high-silica red ores will be of particular value in view of the large quantity of lean ores closely associated with the beds of ore of present workable grade in the Birmingham district.

Publications of the United States Geological Survey on iron-ore deposits issued in 1922 were as follows:

Bayley, W. S., Brown hematite ores of western North Carolina: Bulletin 735-F, 51 pp.

Bayley, W. S., General features of the magnetic ores of western North Carolina and Eastern Tennessee: Bulletin 735-G, 61 pp.

Sources of Iron.

The forms in which iron occurs in the earth in combination with other substances are very numerous. Nearly all hard rocks, as well as the softer soils, sands, clays, and many "mineral" waters contain iron in some combination and in varied proportions. Iron is seldom found "native"—that is, occurring in the earth in the form of metallic iron. When it is found in the metallic state, as, for instance, in meteorites that have fallen from space upon the earth, it is not in quantities large enough to be of commercial value. The combination of iron with one or more other substances is called an iron compound, or iron mineral, and where the iron compounds are such that iron can easily be extracted from them and they occur in such abundance that they can be mined profitably these iron compounds are called iron ores.

Iron in combination with other substances is regarded next to aluminum, a metal contained in clay, as the most abundant metal. Thus, according to recent calculations,* metallic iron forms about 4.50 per cent of the rock crust of the earth, compared with 7.85 per cent. for aluminum.

*Clarke, F. W., The data of geochemistry, 3d ed.; U. S. Geol. Survey Bull. 616, p. 34, 1916.

Iron Ore.

There are four important types of ores of iron—red iron ore, or hematite; brown ore, or limonite; magnetic ore, or magnetite; and carbonate ore, or siderite—although there are hundreds of minerals in which iron is a constituent. These types of ore may easily be remembered through their most common colors, which are, respectively, red, brown, black and grayish.

Hematite.

Hematite includes all varieties of the anhydrous sesquioxide (Fe_2O_3). This is known locally as red hematite, specular ore, gray ore, fossil ore, oolitic ore, etc. Hematite is composed of two parts of the metal iron united with three parts of oxygen. Iron forms 70 per cent. by weight of pure hematite and oxygen 30 per cent., and the mineral is known chemically as the sesquioxide of iron or ferric oxide. Hematite may occur as a rock in beds, in veins, or in masses of irregular shape, and it may occur in a soft, earthy state, or as loose debris in the soil, and yet in all these forms be profitably mined if the controlling conditions are favorable. Hematite is easily recognized in the hand specimen by its colors (red to steel gray and black) and the red mark or streak it leaves when drawn across a rough surface and by its high specific gravity or superior weight as compared with the weight of pieces of ordinary red rock or red clay of equal size. The old-fashioned "keel" or red chalk-stone formerly used by carpenters for marking lumber is a form of hematite. Finely ground hematite is used in the manufacture of red paint and other red coloring materials.

Hematite is by far the most important iron ore. It is found in great abundance in the United States in the vicinity of Lake Superior in Minnesota, Michigan, and Wisconsin; in central New York; in the Appalachian region of Alabama, Georgia, Tennessee, and Virginia; and in eastern Wyoming. It also occurs in lesser quantities in Pennsylvania, Maryland, Kentucky, eastern Wisconsin, Utah and California. (E. F. B.)

All the ore of this quality mined in Alabama occurs in the Clinton or Red Mountain formation. The Red Mountain ridges occur on each side of the anticlinal valleys which separate the coal fields. In places the red ore ridges are lacking

on one side, usually the western, of the valleys, being cut out by faults, while on the other hand the ridge may be duplicated on one side of the valley by the same faults.

In most of the valley occurrences the moderate dips of the ore bed are on the eastern side and there are also practically all of the ore mines. Murphree's Valley makes an exception to this, the moderate dips and the iron mines being on the western side. The iron ore occurs mainly in the central part of the formation in seams or beds one to five in number, which vary in thickness from a few inches to thirty feet.

While the ore seams are very persistent along the outcrop which in Alabama must be as much as fifty miles, yet they vary greatly from place to place, being either too thin or too lean for profitable working in the greater part of this distance.

The most important development of the Clinton ore in this State and in the world is along the fifteen or sixteen miles stretch of the east Red Mountain between Birmingham and Bessemer, and there is practically a continuous series of mines and strippings for this entire distance. Much mining of this ore has also been done near Gate City, Village Springs, Attalla, Gadsden, Round Mountain, Gaylesville, Fort Payne, Valley Head, etc.

The completion in October, 1912, of a diamond drill boring in Shades Valley, within a mile of the base of Shades Mountain, gives a definite answer to the speculations concerning the occurrence of red ore under Shades Valley. This boring shows that there is no falling off in the thickness and quality of the ore with distance from the outcrop, and that the depth of the ore below the surface at a distance of more than 2½ miles from the outcrop of Red Mountain is not too great for shaft mining.

The importance of this demonstration of a vast increase in the amount of red ore available immediately or in the near future, cannot well be overestimated.

In 1913 the Gulf States Steel Company acquired about 1,500 acres of land upon which the drill hole above mentioned was located. They have since sunk a double track slope to the ore. In time this is likely to be the largest producing mine in the State.

Another drill hole was put down in Shades Valley in 1913, in Section 19, T. 19, R. 3 W., but the record was not available for publication at the present time.

The amount of hematite produced in Alabama in 1922 amounted to 4,619,395 long tons as compared to 2,644,020 tons in 1921, an increase in ore mined of 78.4 per cent.

The price of hematite showed a drop of 10.4 per cent to an average price of $1.54 per gross ton for the year.

Brown Ore.

Brown ore is composed of iron, oxygen and water, and in a general way might be said to be hematite combined with water. A general formula may be expressed by $mFe_2O_3nH_2O$. Brown ore may contain water in several proportions so that the percentage of iron likewise varies, but the latter ranges generally from 52 to 66 per cent. in the pure mineral. Thus brown ore does not contain quite as high a percentage of iron as hematite, and therefore it cannot yield so much metal. One of the most common brown ore minerals is known as limonite ($2Fe_2O_33H_2O$), and this contains 59.9 per cent. of iron, 25.7 per cent. of oxygen, and 14.4 per cent. of water. Brown ore occurs in a large variety of forms, nearly all of which have in common a characteristically yellowish-brown to chocolate-brown color and yield a brown streak and powder. Exceptionally certain hydrated sesquioxides of iron may appear bright red, and some may show black surfaces; but these exceptional forms are generally to be found closely associated with a mass of ordinary brown ore, and familiarity with the deposits soon dispels any perplexity regarding the nature of the ore on the part of persons mining or handling it. The specific gravity of brown ore is also higher than that of ordinary rock. Brown ore commonly occurs in irregular masses and lumps, and as ore gravel and sand, embedded in banks of clay, sand, and stone gravel. The ore in places lies in layers, but more commonly in irregular pockets, separated by barren clay, sand, and stone gravel. In places the ore takes the form of hollow concretions or "pots" which may contain some loose sand or clay in the interior and also it appears as honeycombed masses ramifying through the inclosing ore-bearing ground.

Limonite is used chiefly as a source of iron, but the brown and yellow forms, called ocher, are used for paint and for making oil-cloth and linoleum. A porous variety of limonite is used in the purification of illuminating gas, and also as a

contact material in the production of hydrogen gas for inflation of dirigible balloons and for precipitation of fats from oils. Many iron compounds are used in medicines.

Deposits of brown iron ore are common in many portions of the eastern United States, particularly in valleys underlain by limestone. Some of the best-known deposits are in Connecticut, Vermont, Pennsylvania, Virginia, Tennessee, Alabama, northeastern Texas, and in Iowa and Wisconsin near the Mississippi river. (E. F. B.)

This ore is of second importance in the State and third in the United States, but it furnishes only a small per cent. of the total production of the United States. The total brown ore produced in the United States in 1922 was 783,582 long tons. Alabama holds first place with a production of 615,173 long tons or 78.6 per cent of the total production in the United States.

In the early days of iron making and up to the year 1876 this was the only ore used in the catalan forges, bloomaries, and charcoal furnaces of the State. It was then demonstrated that good iron could be made at low cost from the red ores, with coke for the fuel.

In general the limonites are considered the best of the ores of Alabama, commanding the highest prices and a ready sale.

The usual mode of occurrence is in irregular masses of concretionary origin in the residual clays resulting from the decomposition of limestones, and as a consequence the mining is uncertain and expensive. Limonite also occurs in regularly stratified seams or beds, and then it is the result of the alteration of pyrites or of carbonate ores. Practically all of the brown ore actually mined is that occurring in the residual clays above mentioned. Most of the ore before going to the furnace is washed and screened, and this manipulation, together with the cost of mining, makes it the most expensive of the iron ores, and it is therefore seldom used alone, but is usually mixed with the red ore in proportions determined by the quality of the iron desired. It is used alone in the charcoal furnaces and also in the coke furnaces when a particularly tough pig iron is wanted.

The limonite deposits are very numerous and are distributed over a broad expanse of country and in many places are known

to be very extensive. In some of the deposits the ore is in nearly solid mass, in others it is much scattered, and in consequence the amount of foreign material necessary to be removed for every ton of ore produced, varies very much, not only in different ore banks, but also in the different parts of the same bank.

The deposits occur in nearly all the geological formations of the State, but in most of these the ore is either insufficient in quantity or not pure enough to be of much commercial value. The most important of the deposits, in point of extent and value, occur overlying the following formations, viz., the Knox Dolomite and the Weisner Quartzite, the Lauderdale Chert of the Lower Carboniferous, and the Lafayette. Some extensive beds of ore of inferior quality generally occur also in the Tuscaloosa formation of the Cretaceous, and in the upper part of the Lower Carboniferous and in the Metamorphic rocks.

The average price of brown ore was rather constant during 1918, and 1919, but in 1920 there was a large increase in the price. The price in 1919 was $3.52 per long ton and increased to $4.26 per long ton in 1920.

Magnetite.

Magnetite (Fe_3O_4) is a black ore of iron which is attracted by the magnet. It contains iron and oxygen in the proportion of 3 parts of iron to 4 parts of oxygen, which by weight gives 72.4 per cent of iron and 27.6 per cent of oxygen. Magnetite thus contains the highest percentage of iron of the ores thus far mentioned, and in fact, of all the iron ores. Magnetite usually occurs in granular form and in crystals in veins in comparatively old crystalline rocks, although it may be found in comparatively young volcanic rock.

Magnetite is found in the United States in considerable quantities in the Adirondack region of New York, the Highlands of New Jersey, South Pennsyvalnia, Eastern Wyoming, Central Texas, Southwestern Utah, and Southern and Northern California, and in small quantities in Northern Michigan and in other states. It is used chiefly for the production of iron, but the less common variety known as lodestone, which is naturally magnetic, is sold at high prices for museum ex-

hibits and for laboratory purposes. Magnetite is found in the form of sand along streams and on shores of lakes or seas where it has been concentrated by the action of the water. In this form it has not proved of much commercial value as an ore of iron. (E. F. B.)

There has been no development of magnetic ore properly speaking, in Alabama. The gray ore of Talladega County which was mined to some extent a few years ago is essentially a hematite though some of it is slightly magnetic. There was no production of this ore in 1918. (E. A. S.)

Siderite.

Siderite, or iron carbonate ($FeCO_3$), is composed of 1 part of iron, 1 part of carbon, and 3 parts of oxygen and thus contains by weight where pure, approximately 48.3 per cent. of iron, 10.3 per cent. of carbon, and 41.4 per cent. of oxygen. Iron carbonate ore where fresh is generally grayish in color, and occurs in nodules and in layers principally in sedimentary rocks that contain coal and lignite. The carbonate rapidly changes to brown ore on exposure to moist air. Siderite is known locally as spathic iron ore, kidney ore, clay ironstone, and blackband ore. Certain of these names are derived from the appearance of the ore in its different forms. For instance, a bed of carbonate ore that is found on the top of the coal bed in eastern Kentucky is striped with fine black carbonaceous bands.

Iron carbonate, in addition to being found in Kentucky, is common in southeastern Ohio, and occurs to a small extent in Pennsylvania, Alabama, Mississippi and Texas.

IMPURITIES IN IRON ORE.

Consideration should be given to some of the principal impurities that are found in iron ores, first, in order to appreciate why a deposit of ore never yields the full percentage of iron that the predominant iron mineral contains, and, second, in order to show the relation of the ore to the operation of the blast furnace. Deposits of iron ore are generally so closely associated with the rocks which inclose them that they contain either mixed with the deposit or chemically combined within

it some of the other rock-forming minerals. Among the most common of these minerals are silica, or sand; lime and magnesia, derived from limestone and dolomite; alumina, a clay mineral; manganese, a metal resembling iron; and small quantities of sulphur and phosphorus. The presence of varying percentages of these and other minerals tends, of course, to reduce the percentage of metallic iron that the deposit will yield when mined, and they must be removed as far as possible in mining and almost completely in the process of making iron. Therefore, it is of the utmost importance that the average chemical composition of a deposit of iron ore be ascertained before an attempt is made to mine it.

The average composition may be termed the "quality" of the deposit. The quality is determined chiefly by two men, the prospector and the chemist. The prospector digs trenches and pits or drills holes in the ores and takes samples of it. The chemist analyzes these samples of ore in his laboratory, and finds the percentages of metallic iron, silica, lime, alumina, manganese, sulphur, phosphorus, water, etc., contained in average samples of the ore. On the quality of the ore depends the quantity of fluxing stone and fuel that must be used in the blast furnace and the kind of iron that can be produced.

RANGE IN COMPOSITION.

Many chemical analyses of commercial grades of these iron ores indicate a range in composition given in the following table:

Range in chemical composition of commercial grades of iron ore.

	Hematite Per cent	Brown ore Per cent	Magnetite Per cent	Carbonate Per cent
Metallic iron	25-65	35-58	48-70	25-48
Silica	2-35	3-23	0.6-20	1-23
Alumina	0.2-9	1.4-12	0.7-4.5	1-5
Lime	Trace to 27	0-0.6	0.5-4.5	0-7
Manganese	Trace to 5	0.16-5	0.07-1.5	0.1-4.7
Sulphur	Trace to 1.5	Trace to 0.5	Trace to 1.2	0.01-1.8
Phosphorus	0.013-1.23	0.04-1	Trace to 1.75	0.043-0.7
Titanium	0-0.9	....	0-1.5	0-0.04
Water	0.3-6	8.8-15	0.25-0.5	0-6.5

Under exceptional conditions ores are mined that contain more or less of the common constituents indicated above, but local conditions may determine whether an ore that falls within the limits shown may be mined. For instance, hematite carrying as little as 20 per cent, metallic iron would not be considered of value as an ore unless it contained enough lime to flux the silica and alumina present. Most Southern red hematites contain considerable quantities of lime and are therefore workable where a highly siliceous ore carrying no more metallic iron and little lime would not be available under present conditions of metallurgic practice. At present ores averaging less than 25 per cent. of metallic iron are not charged into blast furnaces in any considerable quantities, and ores as lean as this can not be used economically unless they carry more than enough lime to flux them and are used in connection with richer ore. In using limestone as a flux it would probably be more desirable to use a stone carrying 15 to 20 per cent, of ferric oxide (10.5 to 14 per cent. metallic iron) than one containing only 3 to 5 per cent. ferric oxide, on account of the higher iron yield of the former. Nevertheless, the more ferruginous limestone would not commercially be classed as an ore; yet a bed carrying 35.5 per cent. oxide (25 per cent. metallic iron), although in itself not quite rich enough might be conceded to be an "ore." There are other exceptions to be noted in this table. Some deposits of nontitaniferous magnetite can be so treated by means of crushing and electromagnetic separation that, although they may contain as little as 25 per cent. metallic iron, they will yield a high grade concentrate. Such ores may be used to advantage, especially where they can be concentrated along with richer grades. Considerable phosphorus is present in the mineral apatite associated with Adirondack magnetite; and this and silica are largely eliminated by electromagnetic concentration. The possibilities of various methods of concentration or beneficiation must therefore be taken into consideration in appraising an ore, and this involves consideration of the physical as well as the chemical character of the ore. The content of water is a widely variable item. Some ores contain much absorbed water, which can be driven off by drying. Hematite is found in all stages of hydration, and thus may contain water up to the point where

it should really be classed as a brown ore. Hydrated ores are thus concentrated by heating to drive off the chemically combined water. Carbonate ores are calcined to drive off both carbon dioxide and water. Some iron oxides are subjected to a partial reduction and are thus rendered magnetic, and the separation of nonmetallic impurities is thereby greatly facilitated. One brown-ore deposit that averages in the raw state not more than 30 per cent. of metallic iron is thus through a complicated process of beneficiation rendered of commercial value. The question of beneficiation is therefore becoming increasingly important; and there must also be taken into consideration the proximity to transportation, and to blast furnaces, to water-power sites for possible electric reduction, as well as the prevailing conditions of the market. The laws of supply and demand that prevail make available lower grades of ore than would be considered desirable in times when low prices for iron and steel are current. The question of quantity available is also of importance, for iron ore is so bulky a product, is relatively so low in value even at the best, and involves so large an expenditure for equipment for mining on a satisfactory scale that any deposit should contain several years' supply to be worthy of development.

To summarize, then, the ore should occur in a deposit containing several hundred thousand tons of merchantable grades, susceptible of economical mining and convenient to transportation and markets, if its development is to be seriously considered. (E. F. B.)

BENEFICIATED IRON ORE.

The processes reported as employed in 1922 to improve the quality of the ore at mines were crushing and screening, drying by direct heat and by steam, hand picking on tables and on belts, washing by means of hydraulic jets and logs, jigging, electromagnetic separation, sintering, calcining, nodulizing, and desulphurization by sintering. Some of the operations combined two or more of these processes. Iron ores were reported as beneficiated at 83 mines in 12 States in 1922 and at 59 mines in 12 States in 1921. Some iron ore is also recovered in the form of dust from blast furnaces, but no statistics have been gathered on this subject. Ore so recovered has been

originally accounted for in the statistics of shipments from the mines.

The most significant step in the field of beneficiating iron ore was the establishment on a shipping basis of the plant of the Mesabi Iron Co. at Babbitt, Minn. Here a metamorphosed rock containing 20 to 30 per cent of magnetite is crushed and ground very fine, and the magnetite is separated from the siliceous material by dry and wet magnetic separation, after which the concentrates are sintered to facilitate shipment. Prior to the starting of this plant in the fall of 1922 the Minnesota School of Mines experiment station and the Mesabi Iron Co. had been studying the problem of concentrating the magnetite in the rock of the eastern portion of the Mesabi range and had demonstrated that a very superior grade of ore could be produced in an experimental mill. It is probable that eventually the capacity of the plant at Babbitt will be increased so that large quantities of ore can be produced, for economical operation is believed to depend upon a large production.

The next logical step in the problem of beneficiation of iron ores, not only in the Lake Superior district but wherever there are lean hematites and limonites in large quantities convenient to transportation and markets, should be to develop a commercially successful process for reducing the hematite or limonite to a magnetic condition and then separating the magnetic ore from the nonmetallic impurities by electromagnetic action, as is now being done at Mineville, N. Y., and Mesabi, Minn. Such a process was employed for a time by the Mississippi Valley Iron Co. at its brown ore mine near Waukon, Iowa, but this plant has been inactive since 1918. Outlines of this process have been published by the Geological Survey.* As in the initial stages of development of the wet magnetic concentration process, the way to magnetic roasting (or reduction) is also being blazed by the Minnesota School of Mines Experiment Station.†

The total beneficiated ore reported as shipped from mines in the United States in 1922 increased 78 per cent in quantity and 66 per cent in value, as compared with 1921. From such

*Burchard, E. F., Iron ore in Cass, Marion, Morris, and Cherokee counties, Tex.: U. S. Geol. Survey Bull. 620, pp. 103-104, 1915; see also Mineral Resources, 1916, pt. 1, p. 534, 1918.

†Davis, E. W., Magnetic concentration of iron ore; Minnesota School of Mines Exper. Sta. Bull. 9, 138 pp., December, 1921; Magnetic roasting of iron ores: Iron Trade Rev., Apr. 6, 1922, pp. 968-972.

figures as are available, showing the relation between the crude ore treated and beneficiated ore recovered, it is apparent that in washing brown ore the ratios, by weight, of crude ore washed to resultant concentrates range from 6:1 to 1.25:1; in concentrating hematite from 1.841:1 to 1.051:1; in magnetite from 5.118:1 to 1.059:1; and in carbonate 1.333:1.

Beneficiated iron-ore shipped from mines in Alabama in 1922 amounted to 803,369 gross tons valued at $2,133,695 as compared to 327,792 gross tons valued at $834,431 in 1921.

DETAILS OF IRON ORE PRODUCTION IN ALABAMA IN 1922.

The following tables show details concerning the production of iron ore in the State, together with the rank of the State in mined and marketed iron ore in 1921 and 1922.

Ore mined in Alabama, 1921 *and* 1922, *with percentage of increase in* 1922, *in long tons*

Year	Hematite	Brown Ore	Total Quantity	Percentage of Total U. S. Production
1921	2,644,020	232,121	2,876,141	10.62
1922	4,619,395	615,173	5,234,568	11.10
Increase 1922	2,075,375	383,052	2,358,427	
Percentage	+78.4	+165.0	+81.9	

Iron ore shipped from Alabama mines, 1921 *and* 1922

Year	Quantity (gross ton)	Value
1921	2,835,761	$5,058,161
1922	5,294,520	8,791,069
Increase in 1922	2,458,759	$3,732,908
Percentage	+87.0	+74.0

Average price per gross ton of iron ore shipped from mines in Alabama and United States in 1920, 1921, 1922

	Hematite			Brown Ore		
	1920	1921	1922	1920	1921	1922
Alabama	$2.53	$ 1.74	$1.54	$4.26	$2.50	$2.55
United States	4.09	3.37	3.14	4.19	2.63	2.65

Rank of the first five states in mined and marketed production of iron ore in 1921 and 1922

1921

Rank	State	Mined		Marketed			
		Quantity (long tons)	Percentage of total produc'n	Quantity (long tons)	Percentage of total product'n	Value	Percentage of total value
1	Minnesota	18,093,000	61.00	18,056,000	59.95	$63,138,000	70.1
2	Michigan	7,054,000	23.70	4,981,000	16.80	17,693,000	19.7
3	Alabama	2,927,000	9.8	2,875,000	9.4	6,095,000	7.4
4	New York	470,000	1.59	154,000	0.54	479,000	0.57
5	Wisconsin	247,000	0.83	118,000	0.40	260,000	0.29

1922

1	Minnesota	28,768,960	61.0	30,209,372	59.5	$98,903,398	62.7
2	Michigan	10,453,578	22.0	12,457,856	24.6	43,449,513	27.4
3	Alabama	5,234,568	10.1	5,294,520	10.4	8,791,069	5.5
4	Pennsylvania	780,836	1.6	782,916	1.5	1,022,756	1.5
5	Wisconsin	577,024	1.2	794,673	1.5	2,455,660	1.5

Iron Ore Mines in Alabama.

During the year of 1922 the number of producers of iron ore was argumented by a few more small producers. In 1921 there were 27 mines from which production was reported and in 1922 there were 36. Only eight of the companies reported a production greater than 100,000 tons in 1922 as compared

with eight showing more than 50,000 tons production in 1921. The stock of iron ore at the mines at the end of the year in 1922 was 443,779 tons as compared with 503,721 tons at the end of the year 1921.

In 1922 there were 293 iron-ore mines active, out of which there were 109 mines producing more than 100,000 tons of iron ore each. Of these 109 mines 7 (5 in Minnesota, 1 in Alabama, and 1 in Michigan) produced more than 1,000,000 tons each, as against 5 (3 in Minnesota, 1 in Alabama, and 1 in Michigan) in 1921. Permission has been granted to the Geological Survey by the operators of these large mines to publish their production, and these statistics for the mines in Alabama producing more than 100,000 gross tons are given in the following table. The trend toward large mining units is shown in the production of nearly 90 per cent of the output of the country by the 109 mines that yielded more than 100,000 tons each.

Iron ore mines of Alabama that produced more than 100,000 gross tons each in 1922

Rank	Name of Mine	Nearest Town	Variety of Ore	Gross tons
1	Red Mountain Group	Bessemer	Hematite	2,474,125
2	Woodward Nos. 1, 2 and 3	Woodward	Hematite	922,829
3	Raimund Nos. 1 and 2	Bessemer	Hematite	344,293
4	Sloss Nos. 1 and 2	Bessemer	Hematite	253,565
5	Songo	Bessemer	Hematite	213,121
6	Russellville	Russellville	Brown Ore	176,728
7	Shannon	Birmingham	Hematite	124,916
8	Attalla No. 1	Attalla	Hematite	123,594

IRON ORE PRODUCERS IN 1922

The Alabama Co., Birmingham, Ala. Mines at Attalla, Nos. 1 and 2, Etowah County; Ironaton, Talladega County.

Republic Iron & Steel Co., Youngstown, Ohio. Mines at Raimund, Nos. 1 and 2, Jefferson County; Spaulding, Jefferson County; Tannehill and Houston, Tuscaloosa County.

Sloss-Sheffield Steel & Iron Co., Birmingham, Ala. Mines at Sloss Nos. 1 and 2, Irondale; Nos. 2 and 3, Jefferson County; Russellville, Franklin County; Compton, Blount County.

Tennessee Coal, Iron & Railroad Co., Birmingham, Ala. Mines at Fossil, Ishkooda, Muscoda, Jefferson County; Greeley, Tuscaloosa County.

Robinson Mining Co., Birmingham, Ala. Mines at Keewanee and Valley View No. 2, Jefferson County.

William Siglin, Bluffton, Ala. Mine at Bluffton, Cherokee County
Chamblee Land & Development Co., Tuscaloosa, Ala. Mines at Chamblee, Etowah County.
W. Thom. DeCourcy. Mine at Nelson Mine, Shelby County.
Woodward Iron Co., Woodward, Ala. Mines at Docray, Tuscaloosa County; Woodward Nos. 1, 2, 3 and Songo, Jefferson County.
Jenifer Iron Co., Jenifer, Ala. Mine at Jenifer, Talladega County.
Rock Run Iron Co., Rock Run, Ala. Mines at Langdon, Cherokee County.
Allen-Oden Ore Co., Birmingham, Ala. Mine at Mt. Pinson, Jefferson County.
Gulf States Steel Co., Birmingham, Ala. Mine at Shannon (Oxmoor), Jefferson County.
Alabama Fuel & Iron Co., Birmingham, Ala. Mine at Russellville, Franklin County.
Sheffield Iron Corp., D. A. Karr, Operator, Florence, Ala. Mine at Littleville, Franklin County.
Wilson & Lawler, Stahlman Bldg., Nashville, Tenn. Mine at Russellville, Franklin County.
Shelby Iron Co., Shelby, Ala. Mines at Shelby, Shelby County; Taits Gap, Blount County.
Central Iron & Coal Co., Holt, Ala. Mines at Valley View, Jefferson County; Friedman and Giles, Tuscaloosa County.

PIG IRON.

SHIPMENT, VALUE AND PRODUCTION, BY STATES.

THE shipments of pig iron, exclusive of ferroalloys, reported to the United States Geological Survey by the manufacturers, represented an increase of 73 per cent in quantity and 56 per cent in gross value as compared with 1921. The values stated represent the approximate amounts received for the iron f. o. b. furnaces and do not include freight costs, selling commissions, and other items which are figured in some of the market prices of pig iron as published in the trade journals.

The pig iron shipped includes the metal produced from foreign as well as from domestic ore. The pig iron derived from ore imported from Africa, Brazil, Canada, Chile, China, Cuba, Spain, and Sweden, although it constitutes a very small percentage of the total production, amounted in 1922 to 649,111 gross tons, valued at $13,640,340, as compared with 165,620 tons, valued at $4,166,656, in 1921. In the manufacture of 1922 of 568,957 gross tons of pig iron, 929,523 gross tons of foreign iron ore, including 19,318 tons of cinder derived from foreign pyrite, was reported to have been used, thus indicating an average pig-iron yield of 61.21 per cent from imported ore: Domestic ore, including 4,265,869 gross tons of cinder, scale, and scrap and amounting to 50,751,559 gross tons, was reported as used in the manufacture of 26,257,253 tons of pig iron, thus indicating a yield of 51.74 per cent in pig iron from domestic materials. The total production of pig iron, exclusive of ferroalloys, reported to the Geological Survey was 26,826,210 gross tons, compared with 16,403,627 tons in 1921, an increase of about 64 per cent.

Pig iron shipped from blast furnaces in the United States, 1921 and 1922, by States

State	1921		1922					
					Increase or decrease		Percentage of increase or decrease	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Quantity	Value
Alabama	1,241,227	$30,195,978	2,223,159	$42,883,424	+981,932	+$12,687,446	+79	+42
Illinois	1,490,638	36,513,263	2,729,172	58,954,675	+1,238,534	+22,441,412	+83	+61
Indiana	1,655,275	36,945,411	2,191,356	43,064,817	+536,081	+6,119,406	+32	+17
Kentucky	28,375	816,372	140,217	2,951,627	+111,842	+2,135,255	+394	+262
Michigan	200,944	5,955,205	595,647	14,791,041	+394,703	+8,835,836	+196	+148
Missouri	17,028	479,957	†	†	*	*	*	*
New York	786,713	18,212,810	1,708,605	37,783,073	+921,892	+19,570,263	+117	+107
Ohio	3,649,835	88,473,082	6,756,648	149,805,909	+3,106,813	+61,332,827	+85	+69
Pennsylvania	6,072,196	148,350,285	9,732,024	221,581,288	+3,659,828	+73,231,003	+60	+49
Tennessee	21,972	595,850	95,326	2,063,376	+73,354	+1,467,526	+334	+246
Virginia	66,916	2,023,268	31,022	793,903	—35,894	—1,229,365	—54	—61
West Virginia	259,312	6,557,498	309,944	7,537,184	+50,632	+979,686	+20	+15
Wisconsin	93,666	2,730,155	209,289	4,970,227	+115,623	+2,240,072	+123	+82
Other States‡	454,522	11,588,658	948,329	20,964,314	+*476,779	+*8,895,699	+*101	+*74
Total	16,038,619	389,437,792	27,670,738	608,144,858	+11,632,119	+218,707,066	+73	+56

†Included under "Other States."
*Decrease for Missouri included under "Other States."
‡1921: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, and New Jersey; 1922: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Missouri, and New Jersey.

Pig iron shipped from blast furnaces in the United States in 1921 and 1922, by grades

Grade	1921			1922		
	Gross tons	Value	Average price	Gross tons	Value	Average price
Charcoal	79,727	$2,964,106	$37.18	232,244	$6,447,924	$27.76
Foundry	2,285,554	58,711,067	25.69	3,877,201	85,587,682	22.07
Basic	7,755,612	179,355,963	23.13	14,359,461	306,257,984	21.33
Bessemer	5,345,646	133,181,663	24,91	7,723,335	175,082,881	22.67
Low phosphorus	74,517	2,759,054	37.03	152,023	4,359,606	28.68
Malleable	325,901	8,179,596	25.10	1,036,786	23,521,993	22.69
Forge	128,062	3,182,081	24.85	211,601	5,063,516	23.93
All other (not ferroalloys)	43,600	1,104,262	25.33	78,087	1,823,272	23.35
Total	16,038,619	389,437,792	24.28	27,670,738	608,144,858	21.98

*Pig iron, including ferroalloys, manufactured in the United States in 1921 and 1922, in gross tons**

State	1921	1922	State	1921	1922
Pennsylvania	6,252,766	9,731,788	Missouri		
Ohio	3,799,613	6,484,162	Iowa		
Illinois	1,612,033	2,625,244	Colorado	226,364	266,716
Alabama	1,207,408	2,230,619	Montana		
Indiana		2,726,727	Washington		
	1,893,611		Maryland	147,189	366,967
Michigan			Tennessee	19,479	123,907
New York		1,772,325	Connecticut		
	968,660		Massachusetts	2,142	1,084
New Jersey			Maine		
Wisconsin		381,030			
	226,863			16,688,126	27,219,904
Minnesota					
West Virginia		460,311			
	264,759				
Kentucky					
Virginia	67,239	49,024			

* American Iron and Steel Institute.

AVERAGE PRICES.

Prices at Blast Furnaces.

The average prices of all kinds of pig iron given in the following table are based on reports of the manufacturers of

the Geological Survey. The figures represent the approximate prices f. o. b. at the blast furnaces and do not include the prices of ferroalloys. The general average price for all grades of pig iron at the furnaces, exclusive of ferroalloys, showed a decrease of 9 per cent for 1922.

Average price per gross ton of pig iron at blast furnaces in the United States, 1917-1922

State	1917	1918	1919	1920	1921	1922
Alabama	$21.64	$30.58	$25.96	$32.70	$24.33	$19.29
Illinois	26.34	30.91	24.42	28.02	24.50	21.60
Indiana	*	29.09	22.51	25.58	22.32	19.65
Kentucky	28.78	34.19	30.06	31.72	28.77	21.05
Michigan	29.93	35.44	32.23	36.22	29.64	24.83
Missouri	*	36.97	33.40	45.04	28.19	*
New Jersey	35.25	34.22	31.48	38.23	*	*
New York	22.98	28.27	26.84	37.02	23.15	22.11
Ohio	27.30	30.31	25.59	29.93	24.24	22.17
Pennsylvania	29.87	31.69	25.86	33.27	24.43	22.77
Tennessee	26.26	34.08	33.10	42.55	27.12	21.65
Virginia	27.93	34.00	31.53	41.21	30.24	25.59
West Virginia	*	*	25.04	32.53	25.29	24.32
Wisconsin	27.39	38.08	29.42	33.98	29.15	23.75
Other States†	24.25	28.52	25.92	33.87	25.50	22.11
Average for United States	27.29	30.89	25.75	31.95	24.28	21.98

*Included under "Other States."

†1917: Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1918: Colorado, Connecticut, Georgia, Maryland, Massachusetts, Minnesota, Washington, and West Virginia; 1919: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Texas, and Washington; 1920: Colorado, Connecticut, Maryland, Massachusetts, and Minnesota; 1921: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, and New Jersey; 1922: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Missouri, and New Jersey.

Average price per gross ton of pig iron at blast furnaces in the United States, 1889-1922

1889	$15.78	1900	$18.85	1911	$14.07
1890	16.43	1901	15.25	1912	13.93
1891	15.50	1902	20.92	1913	15.08
1892	14.32	1903	19.12	1914	13.42
1893	11.90	1904	14.13	1915	13.21
1894	9.76	1905	16.63	1916	16.96
1895	11.14	1906	19.98	1917	27.29
1896	10.47	1907	20.56	1918	30.89
1897	9.85	1908	15.96	1919	25.75
1898	9.90	1909	16.25	1920	31.95
1899	18.00	1910	15.45	1921	24.28
				1922	21.98

COMMERCIAL QUOTATIONS.

The average monthly prices of the principal grades of pig iron, either at the blast furnaces or at the nearest market in 1921 and 1922, according to published market quotations, are summarized in the following table for comparison with figures reported by blast-furnace operators as shown in preceding tables. The average commercial quotations for three of the four grades of iron show an increase and are apparently higher than the average prices reported by the manufacturers, and so in comparing these prices it should be borne in mind that the manufacturers' prices represent weighted averages of what was actually received by them for the metal and that a discrepancy is to be expected between the two sets of prices.

*Average monthly prices per ton of principal grades of pig iron, 1921 and 1922**

Month	Foundry Pig iron at Valley furnaces		Foundry pig iron at Birmingham furnaces		Bessemer pig iron at Valley furnaces		Basic pig iron at Valley furnaces	
	1921	1922	1921	1922	1921	1922	1921	1922
January	$31.92	$19.38	$31.14	$15.96	$32.00	$19.62	$30.00	$18.19
February	28.29	18.92	27.50	15.33	29.63	19.40	27.71	18.00
March	25.89	18.87	25.52	15.31	26.70	19.02	24.41	17.89
April	24.81	20.74	23.77	15.74	25.00	20.88	23.00	19.98
May	23.60	24.00	21.80	17.63	24.32	25.08	22.15	24.62
June	22.42	24.00	20.48	18.44	22.88	25.00	21.20	25.00
July	20.40	24.20	20.18	18.56	21.34	25.00	19.52	24.32
August	19.59	29.04	18.70	20.37	20.00	27.74	18.22	26.17
September	20.86	35.02	19.06	25.40	20.00	33.76	19.00	30.08
October	21.00	31.63	19.00	27.04	20.00	33.23	19.24	30.23
November	20.78	28.78	18.56	24.12	20.00	31.70	19.00	28.28
December	20.00	25.92	17.31	22.70	20.00	27.78	19.00	24.96
Average	23.30	25.04	21.92	19.72	23.49	25.68	21.87	23.98

*Metal Statistics, 1923.

DAILY AVERAGE PRODUCTION.

The daily average production of coke and anthracite pig iron by months, during the last seven years, is graphically illustrated in Figure 14. The curves of prices and production show little similarity until the later part of 1920, when the

laws of demand and supply began to operate more normally than in the preceding four or five years.

PRODUCTION BY GRADES AND BY FUEL USED.

The statistics of production of pig iron by grades and by fuel used for 1918-1922, the total production of pig iron, and the number of furnaces in blast in 1921-1922 have been published by the American Iron and Steel Institute as given below. These figures include ferroalloys. Metals made with electricity and with coke and electricity are included in coke pig iron.

Pig iron manufactured in the United States, 1918-1922, *by grades, in gross tons*

Grade	1918	1919	1920	1921	1922
Bessemer and low phosphorus	13,024,966	9,975,934	12,062,084	5,595,215	7,813,203
Basic	18,646,174	14,494,131	16,737,722	7,753,071	13,841,367
Forge	393,932	271,286	318,048	112,748	214,210
Foundry and ferrosilicon	5,145,260	4,916,758	5,957,782	2,568,136	3,976,431
Malleable	1,117,914	1,009,049	1,310,951	457,340	1,051,495
Spiegeleisen	283,853	84,246	111,449	56,423	73,443
Ferromanganese	333,027	185,357	295,447	103,755	150,115
White, mottled, direct castings, etc.	109,518	78,603	132,504	41,438	99,640
	39,054,644	31,015,364	36,925,987	16,688,126	27,219,904

Pig iron manufactured in the United States, 1918-1922, *by fuel used, in gross tons*

Fuel used	1918	1919	1920	1921	1922
Bituminous, chiefly coke	38,422,175	30,549,930	36,300,024	16,579,653	26,995,173
Anthracite and coke	283,592	138,337	302,567	13,743	....
Charcoal	348,877	327,097	323,396	94,730	224,731
	39,054,644	31,015,364	36,925,987	16,688,126	27,219,904

TOTAL DOMESTIC PRODUCTION OF PIG IRON.

The next table shows the production in the United States of pig iron, including the commoner ferroalloys, as far as has been recorded. Statistics by years prior to 1916 will be found in Mineral Resources for 1918 and earlier years.

Pig iron manufactured in the United States, 1810-1922

Year	Gross tons	Year	Gross tons	Year	Gross tons
1810-1860	10,542,548	1911-1915	137,591,093	1921	16,688,126
1861-1870	11,366,963	1916	39,434,797	1922	27,219,904
1871-1880	24,055,278	1917	38,621,216		
1881-1890	56,902,041	1918	39,054,644		778,864,649
1891-1900	98,124,754	1919	31,015,364		
1901-1910	211,321,934	1920	36,925,987		

BLAST FURNACES

The number of furnaces in blast on June 30 and December 31 and the total number of stacks recorded for 1921 and 1922, not including any electric reduction furnaces, are as follows:

Blast furnaces in the United States, 1921 *and* 1922

State	In blast June 30, 1921	Dec. 31, 1921			In blast June 30, 1922	Dec. 31, 1922		
		In	Out	Total		In	Out	Total
Pennsylvania	27	46	115	161	69	90	70	160
Ohio	14	26	54	80	41	58	22	80
Illinois	6	9	17	26	16	18	8	26
Alabama	8	13	30	43	22	25	18	43
New York	3	10	17	27	13	15	12	27
Virginia	2		17	17		4	13	17
Tennessee		1	16	17	2	6	11	17
Colorado	2	1	4	5	3	3	2	5
Missouri	1		3	3			3	3
Oregon			1	1			1	1
Maryland	1	1	6	7	4	4	3	7
New Jersey	1	1	3	4	1	1	3	4
Wisconsin	1	1	6	7	3	4	3	7
Minnesota			3	3	2	3		3
Indiana	7	9	7	16	12	14	2	16
Michigan	2	4	9	13	9	13		13
West Virginia	1	2	3	5	2	3	2	5
Kentucky		1	6	7	2	1	6	7
Georgia			3	3			3	3
Texas			1	1			1	1
Mississippi			1	1			1	1
Connecticut			2	2			2	2
Massachusetts			1	1		1		1
	76	125	325	450	201	263	186	449

FOREIGN TRADE IN PIG IRON.

The quantity of pig iron and ferroalloys, principally ferromanganese and ferrosilicon, imported into the United States in 1922 increased 1,019 per cent, compared with 1921. Separate statistics of imports of ferroalloys, given on page 372, indicate that the imports of pig iron alone (by difference) were 374,666 gross tons in 1922, compared with 26,794 tons in 1921. England, Scotland, and Belgium furnished the largest quantity of these products in 1922.

Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, imported into the United States, 1918-1922, *in gross tons*

Country	1918	1919	1920	1921	1922
North America:					
Canada	5,692	63,091	101,071	9,651	30,889
Cuba	----	30	----	----	----
Mexico	120	5,994	----	----	----
Newfoundland and Labrador	----	----	----	13	----
Panama	----	----	----	----	141
South America: Brazil	----	----	466	----	----
Europe:					
Belgium	----	----	----	12,004	64,480
France	----	----	5	127	41,744
Germany	----	----	----	3,508	5,040
Netherlands	----	----	----	----	3,037
Norway	----	----	----	----	674
Sweden	----	51	105	1,088	413
Switzerland	----	----	----	10	5
United Kingdom—					
England	28,392	32,452	64,008	9,302	246,721
Scotland	----	39	10,208	----	98,950
Asia:					
British India	501	----	1,977	----	----
China	----	8	3,555	4,610	502
Hongkong	----	----	----	250	
Japan	6	----	3,851	2,002	----
Kwangtung	----	----	200	1,213	----
Oceania: Australia	----	----	498	258	----
Total	34,711	101,665	185,944	44,036	492,596

The pig iron exported from the United States in 1922 increased 17 per cent in quantity but decreased 7 per cent in

value, as compared with 1921. Canada was the best customer in 1922, having taken 74 per cent of the total pig iron exported. The average price reported as received per ton was $26.43 in 1922, compared with $32.96 in 1921.

FERROALLOYS

SHIPMENTS, VALUE, AND PRICE.

The statistics of output of ferroalloys in the United States were separated from those of pig iron in these reports in order to arrive at more nearly accurate values for these commodities. Although the quantity of ferroalloys is small compared with the total shipments of pig iron, the prices per ton are so much greater that they would unduly increase the apparent average price of the pig iron if included.

The shipments of ferroalloys of all classes in 1922, according to reports of all producers, increased 70 per cent in quantity and 30 per cent in value, as compared with 1921. The ferrovanadium, ferromolybdenum, ferromanganese, spiegleleisen, ferrotungsten, ferrochromium, and ferrotitanium were made in part or wholly from ore imported from Africa, Bolivia, Brazil, China, Cuba, India, Mexico, New Caledonia, Peru, Russia, and Turkey.

A review of the technical developments and market conditions of the ferroalloy industry, with comments on the effect of the new tariff duties, was published early in 1923,§ but lack of space precludes any attempt to make an abstract of this excellent paper.

In 1922 ferromanganese was reported as made at 6 localities in the United States, spiegeleisen at 4, ferrosilicon at 11, ferrophosphorus at 2, ferrochromium at 6, ferromolybdenum at 2, ferrotitanium at 2, ferrotungsten at 6, ferrozirconium at 1, zirconium-ferrosilicon at 1, ferrocarbide at 1, ferrovanadium at 6, and silico-manganese at 1. In many localities, of course, several alloys were made at the same plant. There were 20 plants at which ferroalloys were made electrically or by a special process not involving a blast furnace.

The following records of average contract prices of ferromanganese and of spiegeleisen by months for the last four years show a wide range. The ferromanganese prices are quoted for material "delivered at Pittsburgh;" those of spiegeleisen are prices at producers' furnaces.

§Anderson, R. J., The ferroalloy industry in 1922: Iron Age, Jan. 4, 1923, pp. 58-61.

Ferroalloys of domestic manufacture shipped from furnaces in the United States, 1921 *and* 1922

Variety of alloy	1921		1922	
	Gross tons	Value	Gross tons	Value
Ferromanganese*	111,374	$13,654,800	161,612	$10,672,638
Spiegeleisen	†69,230	†2,838,692	70,253	2,162,836
Ferrosilicon (7 per cent or more silicon)	55,099	2,548,827	154,866	7,109,928
Ferromolybdenum	19	43,866	108	267,168
Ferrotungsten	195	193,914	610	641,238
Other varieties‡	12,710	2,417,686	35,831	7,404,196
Totals	248,627	21,697,785	423,280	28,259,004

*Includes a small quantity of silico-manganese.
†Includes a small quantity of silico-spiegel.
‡1921: Ferrocarbide, ferrocerium, ferrochromium, ferrophosphorus, ferrotantalum-columbium, ferrotitanium, ferrovanadium, ferrozirconium, and zirconium-ferrosilicon; 1922: Ferrocarbide, ferrochromium, ferrophosphorus, ferotitanium, ferrovanadium, ferrozirconium, and zirconium-ferrosilicon.

Quoted prices per ton of ferromanganese and spiegeleisen, 1919-1922*

Month	Ferromanganese (Delivered at Pittsburgh)				Spiegeleisen (At producer's furnace)			
	1919	1920	1921	1922	1919	1920	1921	1922
January	†$212.50	$146.00	$101.00	$61.90	‡$67.50	$46.60	$46.25	$25.50
February	165.00	160.00	96.85	65.32	‡52.50	57.60	37.75	28.00
March	134.00	172.00	89.00	67.82	‡42.50	60.40	34.20	28.00
April	113.75	200.00	87.50	69.07	‡34.50	66.85	32.00	30.00
May	110.00	200.00	83.00	72.32	‡31.35	75.00	31.75	35.00
June	111.75	198.00	76.50	72.82	‡27.50	75.00	29.60	35.25
July	111.00	190.00	75.00	72.29	34.00	75.00	27.50	35.00
August	110.00	193.75	70.75	72.29	34.00	79.35	26.20	37.00
September	105.00	172.40	64.75	80.59	34.00	82.00	25.25	38.00
October	110.00	156.40	61.65	105.47	34.00	80.00	24.85	37.75
November	110.00	153.00	60.00	104.91	34.00	74.35	25.00	36.80
December	121.00	120.00	60.00	104.91	39.00	64.40	25.00	35.75

*Iron Trade Review.
†Price for January, 1919, based on 70 per cent ferromanganese; all other prices based on 80 per cent.
‡Prices from January to June, 1919, inclusive, based on 16 per cent spiegeleisen; all other prices based on 20 per cent.

STEEL.

PRODUCTION.

The following tables showing the production of steel were compiled by the American Iron and Steel Institute. No data whatever are available on the value of the output of crude steel at the mills, but the weekly issues and annual statistical reviews of the Iron Age give market quotations of prices of steel billets and some of the leading forms of finished steel. Prices of the principal items remained nearly the same in 1921 and 1922. The price of Bessemer steel billets at Pittsburgh in 1922 ranged from $28 to $40 a gross ton; in 1921 it ranged from $29 to $43.50. Tank plates at Pittsburgh ranged from 1.39 to 2.13 cents a pound in 1922 and from 1.50 to 2.65 cents in 1921. Steel beams at Pittsburgh ranged from 1.39 to 2 cents a pound in 1922 and from 1.50 to 2.45 cents in 1921.

Bessemer steel ingots and castings manufactured in the United States, 1918-1922, *in gross tons*

State	1918	1919	1920	1921	1922
Ohio	3,920,442	3,073,941	3,662,718	1,581,610	2,324,425
Pennsylvania	3,281,941	2,851,402	3,279,023	1,665,456	2,474,956
Illinois	1,229,568	906,324	1,243,837	532,539	707,067
Other States	944,285	439,895	697,509	236,333	412,850
	9,376,236	7,271,562	8,883,087	4,015,938	5,919,298

Open-hearth steel ingots and castings manufactured in the United States, 1918-1922, *in gross tons*

State	1918	1919	1920	1921	1922
New England States	329,630	286,826	290,967	102,642	204,343
New York and New Jersey	2,245,239	1,296,005	2,010,895	634,290	1,597,881
Pennsylvania	15,574,101	12,692,112	14,184,477	6,408,043	11,583,812
Ohio	6,729,955	5,112,616	6,341,016	3,108,332	6,770,293
Indiana	3,910,899	3,122,486	3,785,056	2,308,414	3,571,397
Illinois	2,283,991	1,664,993	2,302,776	1,093,268	2,077,920
Other States	3,385,576	2,773,656	3,756,708	1,934,813	3,503,337
	34,459,391	26,948,694	32,671,895	15,589,802	29,308,983

According to these tables there were increases of 47 per cent in the production of Bessemer steel and of 88 per cent in open-hearth steel in 1922 compared with 1921. In the total production of steel there was an increase of 80 per cent. Of the total output in 1922, 82 per cent was represented by open-hearth steel, 17 per cent by Bessemer steel, and 1 per cent by all other classes of steel.

Of the total output of open-hearth steel, 28,387,171 gross tons was made by the basic process and 921,812 tons by the acid process, compared with 15,082,564 tons of basic and 507,238 tons of acid steel in 1921.

The production of steel by the electric process in 1922 showed an increase of 104 per cent as compared with 1921.

Steel electrically manufactured in the United States, 1909 *to* 1922, *in gross tons*

Year	Ingots	Castings	Total	Year	Ingots	Castings	Total
1909	13,456	306	13,762	1916	126,048	42,870	168,918
1910	50,821	1,320	52,141	1917	239,632	64,911	304,543
1911	27,227	1,878	29,105	1918	403,068	108,296	511,364
1912	14,147	4,162	18,309	1919	272,942	111,510	384,452
1913	20,973	9,207	30,180	1920	346,956	155,196	502,152
1914	15,458	8,551	24,009	1921	84,404	85,095	169,499
1915	46,348	23,064	69,412	1922	191,057	154,982	346,039

In the total production of electric steel in 1922 are included 125,419 tons of alloy-steel ingots and castings which were alloyed with nickel, vanadium, tungsten, chromium, molybdenum, and other metals (107,659 tons of ingots and 17,760 tons of castings), compared with 62,618 tons (53,162 tons of ingots and 9,456 tons of castings) so alloyed in 1921.

On December 31, 1922, the number of completed plants equipped for the manufacture of steel by the electric process was 203, as compared with 198 plants at the end of 1921. On January 1, 1922, it was reported that there were 388 electric furnaces of all types in the United States and 50 in Canada, and at the end of the year there were 406 in the United States and 50 in Canada. The total number of furnaces in the world at the beginning and end of 1922 was estimated at 1,000 and 1,175, respectively, as compared with 140 in 1913.

Steel produced in the United States, 1810-1922, *in gross tons*

Year	Bessemer	Open-hearth	Crucible	Other steel	Total
1810-1870	58,482	2,232	146,370		207,084
1871	40,179	1,785	31,250		73,214
1872-1880	4,293,896	245,035	349,730	76,009	4,964,670
1881-1890	21,596,699	2,387,925	703,489	37,044	24,725,157
1891-1900	49,387,341	15,392,764	762,446	35,820	65,578,371
1901-1910	94,048,698	92,418,814	1,051,379	154,683	187,673,574
1911-1915	42,329,520	98,833,090	544,047	185,692	141,892,349
1916	11,059,039	31,415,427	129,692	169,522	42,773,680
1917	10,479,960	34,148,893	126,716	305,038	45,060,607
1918	9,376,236	34,459,391	115,112	511,693	44,462,432
1919	7,271,562	26,948,694	63,572	387,404	34,671,232
1920	8,883,087	32,671,895	72,265	505,687	42,132,934
1921	4,015,938	15,589,802	7,613	170,444	19,783,797
1922	5,919,298	29,308,983	28,606	346,039	35,602.926

LIME.

PRIOR to 1919 the limestones of Alabama were not extensively used for the burning of lime, but during this year the State came to the front and ranked as one of the leading lime producing States. Since the beginning of extensive production in 1919, Alabama has remained among the leading lime producing States, ranking seventh in 1921, and sixth in 1922.

The year 1921 saw a general curtailment of the industry in Alabama. Old established plants shut down and new projects were held in abeyance or entirely dropped because of the slim margin of profit. Toward the close of 1921 the demand for lime increased. Alabama was not slow to respond to the firm tone of the market and 1922 shows an increased output with one more producer than in 1921.

The total product from the eleven plants in 1922 was 168,135 tons valued at $979,331 as compared to 109,256 tons valued at $847,629 in 1921. The average price in 1922 was $5.82 per short ton as compared to $7.76 in 1921.

In 1922 lime for building purposes created the largest market, the amount used for metallurgical purposes being second. Other uses of lime are chemical, paper mills, agriculture, sugar factories, tanneries, slag cement, etc.

Owing to the large production by the Tennessee Coal, Iron and Railroad Company, Jefferson County is foremost in the production, followed in order by Shelby and Blount Counties.

The following tables give additional data on the lime production in 1922:

Lime burned and sold in Alabama, 1922

YEAR	Rank of state by quantity	Quantity (short tons)	Value	Rank of state by value	Average price per ton	Number of plants in operation
1921	7	109,256	$847,629	10	$7.75	10
1922	6	168,135	979,331	9	5.82	11
Change 1922		+ 58,889	+ 131,702		— 1.93	
Per cent		53.0	15.5		— 24.8	

Lime sold in Alabama in 1921 and 1922 by uses.

YEAR	Quantity (short tons)	Value	Average price per ton U. S.
1921			
Building lime	32,397	$296,550	$9.52
Metallurgy	*	*	6.93
Paper mills	*	*	8.53
Sugar factories	*	*	8.54
Tanneries	*	*	7.86
Agriculture	*	*	8.40
Dealers, uses not specified			
Other uses, and undistributed	66,859	551,079	8.70
Total	109,256	$847,629	$7.75
1922			
Building lime	48,471	$392,349	$10.01
Metallurgy	*	*	7.26
Paper mills	*	*	8.65
Sugar factories	*	*	12.09
Tanneries	*	*	9.78
Agriculture	*	*	7.35
Dealers, uses not specified			
Other uses and undistributed	89,709	402,618	8.37
Total	168,135	$979,331	$8.32

Hydrated Lime.

During the year 1922 there were 15,016 short tons of hydrated lime produced valued at $140,698 as compared to 7,030 short tons valued at $66,480 in 1921. An increase of 7,986 short tons and in value of $74,218. The production of hydrated lime in 1921 was 6.4% of the total production of the State and in 1922 it was 8.5%. The greater part of the hydrated lime was used for building purposes.

Hydrated lime sold in Alabama in 1921 *and* 1922

YEAR	Quantity (short tons)	Value
1921	7,030	$66,480
1922	15,016	140,698
Increase, 1922	7,986	74,218
Percentage	113.6	112.0

KILNS.

By W. E. EMLEY

The accompanying table contains evidence of a certain amount of confusion in the common usage of the names applied to different types of limekilns. It was thought advisable to include kilns called "shaft," "vertical," "continuous," or "gas" in the column headed "flame or patent kilns," assuming these all to be different names for the same thing. It is possible that this assumption may be incorrect.

In order to avoid such confusion in the future, and for the broader purpose of establishing a system of nomenclature within the industry, the following definitions of the different types of kilns are suggested:

A "field" kiln is distinguished from all other types by being intermittent in its operation. Firing is continued until the contents of the kiln are calcined, when the kiln is entirely emptied. Under some conditions it may be demolished and rebuilt after each burn. A "continuous" kiln is a kiln of any type other than a field kiln.

A "pot" kiln is a vertical shift kiln which is continuous in its operation. Its peculiar characteristic is that the fuel and stone are charged into the kiln in alternate layers.

A "flame" kiln is a vertical kiln which is continuous in its operation. Its name is derived from the fact that only the flame of the fuel and not the fuel itself comes into contact with the stone or lime. This type is sometimes known as a

"patent" kiln, but the term "flame" is to be preferred as more significant.

A "rotary" kiln needs no description.

The term "gas kiln" is to be avoided in this connection because it indicates the kind of fuel rather than the type of kiln.

Daily capacity, number of kilns, and kind of fuel used in burning lime in 1922

State	Daily capacity (short tons)	Total kilns in plants	Active kilns in 1922											
			By kind					By fuel used						
			Pot	Patent	Gas	Rotary	Field and unspecified	Coal	Wood	Oil	Natural gas	Producer gas	Coke	Coal and wood
Alabama	692	37	6	21	------	------	1	17	1	------	------	------	2	8

LIME PRODUCERS, 1922

Blount County

Cheney Lime Company

DeKalb County

Alabama Lime Works

W. L. Buckels

Jackson County

Ala.-Tenn. Lime Co.

Jefferson County

Tennessee Coal, Iron & R. R. Co.

Shelby County

Calera Lime Works
Keystone Lime Co.
Long View Lime Works
Newala Lime Works
Milmay Lime Works
Saginaw Lime & Stone Co.
O'Neal's Lime Works

MICA.

By B. H. Stoddard

Introduction.

THAT the mica industry in 1922 showed a decided tendency to recuperate from its depressed condition in 1921 is indicated by reports of production and sales of mica received by the Geological Survey from producers and others in the mica business. The production of both sheet and scrap mica increased in total quantity and value. The average value of uncut sheet mica increased from 16 cents a pound in 1921 to 18 cents in 1922, and the average value of scrap mica decreased from $22 a ton in 1921 to $17 in 1922.

Nature and Occurrence.

Although there are many varieties of mica, only three have been widely used in the industries—muscovite, phlogopite, and lepidolite. Lepidolite is valuable not because of its physical properties but because lithia salts can be extracted from it. Muscovite and phlogopite are valuable because of their unusual combination of physical properties—cleavage, flexibility, elasticity, transparency in thin sheets, nonconductivity of heat and electricity, brilliancy of cleavage flakes, and softness. Other micas—roscoelite, biotite, and mariposite—have been mined in the United States. Roscoelite is a source of vanadium. Biotite, when ground and roasted, is used as a decorative material. Mariposite, a fine-grained greenish mica, is also used for decorative purposes and as a pigment in paint. Clinochlore, although a member of the chlorite group and not a true mica, is used when ground for the same purposes as ground muscovite mica.

Muscovite is a silicate of aluminum and potassium; phlogopite is a silicate of magnesium, aluminum, and potassium. In thin sheets both are transparent when free from impurities, but muscovite is light in color, whereas phlogopite is generally

much darker. In sheets one-sixteenth of an inch or more in thickness muscovite may be colorless, gray, yellow, inclining to amber, red, brown, or green. In sheets less than one-sixteenth of an inch in thickness phlogopite may be yellow or brown and much of it has a coppery appearance.

Except the phlogopite from Canada, nearly all the mica produced in the world is muscovite.

Deposits of white mica (muscovite) of commercial value occur only in pegmatite, an igneous rock similar to granite in composition but much coarser grained. The chief minerals of this rock are quartz, feldspar, and mica, but it contains smaller quantities of other minerals, such as tourmaline, garnet, and beryl. Outcrops of pegmatite are in many places indicated by projecting masses or loose fragments of compact white quartz. The country rocks of most pegmatites that carry sheets of mica of commercial quality are metamorphic rocks, mainly mica schist and gneiss. In some occurrences the pegmatite follows the planes of schistosity of the country rock for considerable distances; in others it cuts across the schistosity. Many pegmatite masses are very irregular in size, shape, and continuity, and some form ledges and lens-shaped bodies of considerable extent. They range in thickness from a fraction of an inch to many yards and in length from two or three times to more than a thousand times their thickness.

Commercial sheet mica is generally scattered irregularly throughout the pegmatite, though in a few occurrences it follows well-defined and regular leads. No definite rule can be laid down for guidance in exploring a pegmatite mass for commercial sheet mica. Each occurrence must be studied in detail, and the particular portion of the pegmatite suitable for mining mica must be determined by actual experience.

Mica is found on the surface as well as at various depths. Much of that found near the surface is weathered and clay-stained, and the weathered zone may extend some distance below the surface. In some sections of the country, however, sheet mica in good condition is found practically on the surface, very little weathering having taken place.

The scales of mica in micaceous sandstone and shale are too small and too scarce to be of any commercial value. Many

of the metamorphic rocks, such as gneiss and schist, contain more mica than sandstone and shale, but here, too, the small size of the mica scales and the impracticability of separating them from the abundant quartz and other hard minerals present has so far rendered such occurrences of doubtful value as a source of scrap mica.

Sheet mica mined for commercial purposes is generally found in irregular blocks or imperfect crystals, which may be rudely hexagonal. Only a small proportion of the mica blocks, averaging about 10%, contain marketable sheets.

More detailed information concerning the nature and occurrence of mica will be found in the Geological Survey's Bulletin 740, "Mica deposits of the United States," by D. B. Sterrett.

Production.

The total sales of uncut sheet mica in the United States for 1922, as reported to the Geological Survey, were 1,077,968 pounds (539 short tons), valued at $194,301, representing increases over 1921 of 45 and 64 per cent, respectively. The scrap mica sold amounted to 6,641 short tons, valued at $114,045, an increase in quantity of 158 per cent and in value of 101 per cent. Alabama, Connecticut, North Carolina, and Virginia are the States that showed increases in the quantity of uncut sheet mica sold, and all States except New Hampshire reported increases in the quantity of scrap mica sold. New Hampshire practically maintained its status of 1921, which was a 73 per cent increase in quantity over 1920. The total quantity of scrap mica sold was the greatest on record, and the total value was exceeded in only one year, 1920, when it was $167,017. Figures for mica production were first recorded by the United States Geological Survey for 1886.

The producing States in 1922 were North Carolina, New Hampshire, Virginia, New Mexico, Georgia, South Dakota, Alabama, Colorado, Connecticut, and South Carolina, named in order of total value of mica sold.

The Mica Products Co., of Denver, Colo., has reported to the Geological Survey (August 1923), through its general

manager, Mr. W. B. Thomas, that its property, 7 miles east of Westcliffe, Custer County, Colo., is under development preparatory to marketing its product, jeffersite. This mineral is a hydrated mica called vermiculite and is said, after heating and exfoliation, to be suitable for various purposes, such as fire brick, wall board, refrigerating, and insulation for steam pipes. It is also said to be useful in paint and rubber, and experiments for using it in the manufacture of dynamite are contemplated. The present developments consists of two shafts 30 and 35 feet deep, open cuts, and 10-foot holes showing seven different veins extending the length of the property, 1,320 feet.

The figures for sheet mica shown in the following table represent uncut sheet and punch mica. A very small quantity of splittings is also included as uncut sheet.

Mica produced and sold in the United States, 1918-1922.

YEAR	Sheet mica		Scrap mica		Total	
	Pounds	Value	Short tons	Value	Short tons	Value
1918	1,644,200	$731,810	2,292	$33,130	3,114	$764,940
1919	1,545,709	483,567	3,258	58,084	4,031	541,651
1920	*1,683,480	*546,972	5,723	167,017	*6,565	*713,989
1921	*741,845	*118,513	2,577	56,849	*2,948	*175,362
1922	*1,077,968	*194,301	6,641	114,045	*7,180	*308,346

*The figures for sheet mica in 1920, 1921, and 1922 represent uncut sheet mica exclusively. In previous years the totals have included some cut sheet mica.

Mica sold by chief producing States, 1918-1922.

YEAR	Sheet mica			Scrap mica		Total	
	Pounds	Short tons	Value	Short tons	Value	Short tons	Value
North Carolina:							
1918	941,200	471	$460,450	1,046	$12,930	1,517	$473,380
1919	1,021,306	511	331,498	1,639	32,338	2,150	363,836
1920	1,084,946	542	405,654	2,823	91,653	3,365	497,307
1921	230,532	115	51,851	1,353	30,496	1,468	82,347
1922	544,495	272	119,767	4,205	65,923	4,477	185,690
New Hampshire:							
1918	376,900	188	106,200	530	7,040	718	113,240
1919	235,724	118	90,915	738	13,356	856	104,271
1920	284,862	142	83,811	435	12,877	577	96,688
1921	491,743	246	63,249	537	10,613	783	73,862
1922	475,647	238	63,240	238	5,838	476	69,078
Virginia:							
1918	78,500	39	46,200	404	4,280	443	50,480
1919	*	*	*	578	7,811	*	*
1920	179,339	90	26,189	*	*	*	*
1921	*	*	*	*	*	*	*
1922	43,449	22	6,577	296	9,718	318	16,295
Georgia:							
1918	208,200	104	77,300	40	2,750	144	80,050
1919	47,018	24	19,682	51	778	75	20,460
1920	50,095	25	13,692	101	3,015	126	16,707
1921	12,730	6	2,640	75	1,700	81	4,340
1922	8,818	4	4,083	224	7,247	228	11,330
Alabama:							
1918	11,800	6	3,150	—	—	6	3,150
1919	*	*	*	—	—	*	*
1920	81,458	41	16,401	222	5,234	263	21,635
1921	—	—	—	—	—	—	—
1922	*	*	*	*	*	*	*

*The figures may not be given, as there were less than three operators.

The following table is based on an aggregate of about 93 per cent of the total production of sheet mica. The figures include all qualities from clear to stained.

Uncut sheet mica sold in the United States in 1922 by sizes

Size	Pounds	Percentage	Percentage with punch omitted
Punch	856,408	85	
1½ by 2 inches	38,547	4	26
2 by 2 inches	30,030	3	20
2 by 3 inches	38,848	4	26
3 by 3 inches	13,168	1	9
3 by 4 inches	9,581	1	6
Larger sizes	19,115	2	13
Splittings	*	*	*
	†1,005,697	100	100

*Splittings may not be shown, as there were less than three producers. The quantity was small.
†This figure represents about 93 per cent of the total of the United States.

MINING.

Deposits of mica are very irregular, and the method of mining them varies accordingly. If the mica is rather evenly distributed ordinary methods of mining, by shaft, adits or tunnels, drifts, and stopes, can be employed; if the mica is scattered, stoped and other working are more irregular and in mining the granitic micas the total quantity of mica is so small a proportion of the vein material as to suggest the type of mining known as "gophering" or "hogging," which is excavating for the purpose of getting what is available, without reference to any system of development. In such workings the waste rock is left to accumulate because of the difficulty of removing it through the small tunnels and openings, and this method soon becomes a hindrance to future development. It is used in some parts of the South, however, and is the only method that can be employed in some mines.

In some large masses of pegmatite regular quarry methods may be used. This is common in the New England mica mines, where mica is mined in open quarries and derricks and inclined tracks are used to remove ore and waste.

Great care is necessary in mining mica to avoid drilling through the crystals or shattering them by heavy charges of powder. Hand drilling is employed in the smaller mines, and

some operators use hammer drills for which compressed air is supplied by steam, gasoline, or electrically operated compressors. In blasting only small charges of low-grade dynamite (usually about 40 per cent strength) should be used around a pocket of mica.

As a general rule a mica prospect should be opened by cuts, shafts, or tunnels along the deposit in any places that appear favorable until mica has been found in paying quantities. Only then should vertical shafts be sunk, either in the mica-bearing pegmatite or at one side of the vein, or long crosscut tunnels may be run from lower levels on a hillside. Few prospects give evidence on the surface that they will warrant extensive development or large outlay in mining equipment.

CLASSIFICATION OF MICA.

Mica is valuable in sheet form and as scrap suitable for grinding into a powder. For commercial sheet mica the individual pieces must be large enough to contain a rectangular area measuring at least 1½ by 2 inches, which must split easily and evenly and be nearly free from "cracks," "rulings," "markings," and all fracture lines and reasonably free from inclusions or specks of foreign mineral matter. The size stated is the smallest rectangular size that is salable in the form of uncut sheet; the irregularly bounded rough-trimmed mica sheet must be nearly twice as large to yield this size—in other words, a sheet that would yield a suitable rectangle 1½ by 2 inches and would be classed as "1½ by 2 inches" would have to measure nearly 3 by 4 inches.

Splittings are the thin films or flakes of mica that are split from the smaller sheet or waste material. They are about one-thousandth of an inch thick and are irregular in shape.

Material suitable as scrap mica for grinding must be free from all foreign matter, especially gritty material such as quartz and feldspar.

The system of classification of mica, by sizes, is different in the United States, Canada, and India. The United States classification is as follows (figures represent inches): Punch, circle, 1½ by 2, 2 by 2, 2 by 3, 3 by 4, 3 by 5, 4 by 6, 6 by 6, 6 by 8, 8 by 10, and larger. For punch mica the uncut sheet must be of sufficient size to yield a circle 1½ inches in diame-

ter if stained and 1¼ inches if clear; circle mica should yield a disk nearly 2 inches in diameter.

Canadian or "amber" mica is also classified on the basis of the size of the rectangle obtainable, but the sizes differ from those used for the United States mica. The sizes used for Canadian mica, in inches, are 1 by 1, 1 by 2, 1 by 3, 2 by 3, 2 by 4, 3 by 5, 4 by 6, and 5 by 8.

The Indian classification is not based on the size of the rectangle obtainable but on the area of usable mica in the sheet. The following table shows the Indian system of grading, with the approximate corresponding sizes used in the United States classification:

Grading of Indian Mica

Grade	Area of usable mica (in square inches), based on rectangular sizes.	Sizes of rectangles that can be cut (in inches)				Approximate corresponding sizes in United States classification (in inches)
		Width		Length		
		Minimum	Maximum	Minimum	Maximum	
6	Less than 3					Punch
5	3 to 5⅞	1	2	2	2½	2 by 2
4	6 to 9⅞	1½	2½	2½	3	2 by 3 3 by 3
3	10 to 14⅞	1½	3	3	4½	3 by 4
2	15 to 23⅞	1½	3½	4½	6	3 by 5
1	24 to 35⅞	3	5	5	7	4 by 6
A-1	36 to 47⅞	4	6	7	9	5 by 8
Special	48 to 59⅞					6 by 8
Extra special	60 to 71⅞					8 by 8
Extra extra special	72 and more					8 by10

PRICES.

Value of domestic mica in the United States, 1918-1922*

Year	Total value	Average value per short ton of all mica mined	Average value per pound of sheet mica
1918	$764,940	$246	$0.45
1919	541,651	134	.31
1920	713,989	109	.32
1921	175,362	59	.16
1922	308,346	43	.18

*Figures for 1918-19 represent average value of cut and uncut mica as reported by producers. Figures for 1920, 1921 and 1922 represent the average value in terms of uncut sheet mica only.

The following table is based in part on statements received from the producers and purchasers:

Average price per pound paid in the South for rough-trimmed sheet mica of good quality split and sorted to cut the sizes indicated, 1919-1922

Sizes in inches	1919	1920	1921	1922
Punch	$0.08	$0.10	$0.06	$0.06
1½ by 2	.55	.51	.35	.15
2 by 2	.95	.84	.55	.35
2 by 3	1.35	1.25	1.00	.75
3 by 3	1.85	2.04	1.40	1.35
3 by 4	2.15	2.37	2.00	1.75
3 by 5	2.55	2.95	2.50	†
4 by 6	3.50	3.85	3.00	2.75
6 by 6		4.00	3.50	†
8 by 10	*	5.00	5.00	3.70
8 by 10		7.00	†	†

*Prices exceedingly variable. †No information available.

USES.

As an insulating material in electrical apparatus and machinery sheet mica is used extensively. In fact, its most important use is in the electrical industry, where a noninflammable, resistant insulating material is necessary. Nearly every piece of apparatus and machinery utilizing electricity must have mica for insulation. In its resistance to puncture, infusibility, and imperviousness to moisture mica is an ideal insulator, and in addition it has physical properties—cleavage, transparency, hardness, elasticity, flexibility, and resonance—which are not found combined in any other substance. It is therefore serviceable for a variety of purposes, such as an electric insulating material in condensers for magnetos for the engines of automobiles, trucks, and airplanes; in condensers for radio-transmission apparatus; and in spark plugs for automobiles, trucks, and airplanes. Condenser mica must be clear, must split easily and smoothly into films as thin as one-thousandth of an inch, and must be free from cracks, holes, foreign substances, stains, spots, and smoke, and the sheets must be plane and smooth, free from waves, wrinkles, reeves, rulings, or knots.

Sheet mica and splittings are used as insulating material in the form of sheets, washers, and tubes in dynamos and in numerous electric fittings and appliances, such as electric heating devices, electric-light sockets, spark plugs, guards in rheostats, fuse boxes, and telephones. Flexible cloth and tape, partly made of or covered with mica, find varied uses in electric apparatus. Sheet mica is used for glazing in the fronts of stoves, in furnace sightholes, for screens in front of highly heated material, for optical lanterns as a retarder of heat waves, and for making lamp chimneys and lamp shades.

As an insulator between the copper segments of the commutators for direct-current dynamos and motors phlogopite or "amber" mica is said to be preferred, as muscovite or "white" mica, being harder, does not wear down evenly with the copper, leaving a ridge above the copper bar that would cause sparking and irregular running. For all other insulation, however, the domestic muscotive is satisfactory.

Phonograph or diaphragm mica must be of a very high grade, for it must be clear and transparent and must also be flat.

Mica for lamp chimneys and canopies must be clear and must split easily and be very flexible. Very little domestic mica can be used for this purpose. Indian and Brazilian mica are used instead.

For stove fronts a nearly clear mica, hard and rigid, is most desirable, and much of the North Carolina mica, especially the greenish, is well adapted for this use.

Sheet mica of an inferior grade and splittings (mostly in the form of built-up mica board) are also extensively used for general electric insulation. Muscovite and phlogopite mica are both suitable for building into mica board. This material is prepared by splitting the mica into thin sheets, systematically placing them together with shellac, and then subjecting the whole to pressure. In this way large composite sheets are made, which are as suitable as single sheets of mica for some insulating purposes. The mica boards manufactured by different concerns are known by special trade names, such as "micanite," "micasbeston," and "micabond."

Most of the mica splittings produced are consumed in the manufacture of built-up mica board, but some splittings are used as such in making mica tubes for spark-plug cores and

other insulating uses, wrapping for wire coils, and insulating tape.

Scrap mica, or mica that can not be utilized as sheet or splittings, is ground and sold in powdered form. Ground mica, usually coarsely ground, is used in patent roofing compositions, and for this purpose biotite or black mica is also suitable. The mica serves the purpose of keeping the material from sticking when rolled for shipping or storage. Ground mica is also used for decoration, chiefly in wall paper, fancy paint, ornamental tile, and concrete facings; as a lubricant; in annealing steel; and as an absorbent for nitroglycerin. Its heat-resisting qualities render it useful in railroad car-axle packings, in pipe and boiler coverings, in fireproof paints, and in rubber tires. Nearly all the mica ground in the United States is obtained from the mining and manufacturing of sheet mica, being the waste obtained in mining and the waste and trimmings resulting from the cutting of the sheet mica.

MICA PRODUCERS IN 1922

Ashland Mica Co., Biltmore, N. C. Mines in Alabama.

MINERAL WATERS.

By W. D. Collins*

Scope of Report.

The term mineral water as it is used in this report applies to water that is bottled and sold in its natural state or only slightly altered from its natural state. It includes (a) natural carbonated waters that have lost part of their carbon dioxide; (b) natural waters that have been artificially carbonated; and (c) waters from which iron has been removed. It does not include artificial waters or natural waters that have been essentially modified in chemical character. Waters that have been flavored, concentrated, fortified, diluted, or otherwise radically altered are therefore not included.

The statistics in this report refer only to domestic mineral waters that have been sold, imports being excepted. Water that is given away, including water furnished free for drinking or bathing to guests at hotels or to patients at sanitariums, has been omitted even where there are data available to show the quantity of water so used. Hence, as actual sales fall far short of the total quantity used, particularly of such waters as are drunk at fashionable resorts for their medicinal value, the totals do not represent the full magnitude of the trade.

Three uses of mineral waters are recognized in this report—table use, medicinal use, and use in manufacture of soft drinks—but the quantity and value of water used in the manufacture of soft drinks are not included in the totals. In former reports the springs whose waters were used only for making soft drinks were included in the number of producing springs. In this report such springs are enumerated separately.

The distinction for statistical purposes between table and medicinal waters is entirely arbitrary and is based on the reports furnished by the owners and operators of springs stating the uses for which the waters are sold.

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*The statistics showing production were compiled by Mrs. E. R. Phillips of the United States Geological Survey.

OUTPUT AND VALUE.

Mineral waters sold in the United States in 1921 and 1922, by States
(Exclusive of water used in the manufacture of soft drinks)

State	1921		1922		Percentage of increase or decrease	
	Gallons	Value	Gallons	Value	Quantity	Value
Alabama	892	$690	5,389	$875	+504	+27
Arkansas	313,322	31,984	248,460	28,866	—21	—10
California	3,260,609	367,313	3,048,324	433,711	—7	+18
Colorado	234,560	70,925	146,626	55,283	—37	—22
Connecticut	866,253	50,679	1,141,421	70,926	+32	+40
Florida	321,472	28,365	1,004,984	57,305	+213	+102
Georgia	306,637	22,757	424,290	36,856	+38	+62
Illinois	351,277	21,871	335,974	18,679	—4	—15
Indiana	541,190	158,790	514,211	156,358	—5	—2
Iowa	21,100	2,105	25,561	3,788	+21	+80
Kansas	421,294	55,982	383,600	64,554	—9	+15
Kentucky	255,475	37,174	191,275	30,430	—25	—18
Maine	744,775	309,757	928,149	368,939	+25	+19
Maryland	888,948	87,138	749,624	73,890	—16	—15
Massachusetts	1,088,921	72,792	1,417,111	81,674	+30	+12
Michigan	1,344,900	154,401	1,229,802	150,237	—9	—3
Minnesota	2,266,578	132,127	2,962,160	156,066	+31	+18
Mississippi	140,600	31,945	100,548	25,966	—28	—19
Missouri	176,541	45,670	141,369	40,149	—20	—12
New Hampshire	225,720	9,599	*	*	......	......
New Jersey	250,295	25,960	290,808	30,800	+16	+19
New York	5,965,049	736,173	6,965,638	800,831	+17	+9
North Carolina	87,052	13,561	65,020	9,941	—25	—27
North Dakota	585,000	8,100	*	*	......	......
Ohio	2,219,149	161,208	2,298,132	162,814	+4	+1
Oklahoma	1,319,895	45,078	1,434,885	46,047	+9	+2
Oregon	2,150	653	2,621	598	+22	—8
Pennsylvania	730,252	74,490	824,988	81,435	+13	+9
Rhode Island	327,352	21,391	279,109	25,704	—15	+20
South Carolina	124,055	18,489	96,900	21,622	—22	+17
South Dakota	*	*	796,500	32,850	......	......
Tennessee	1,150,585	72,227	1,005,119	67,838	—13	—6
Texas	366,429	67,410	307,478	50,737	—16	—25
Vermont	4,500	468	*	*	......	......
Virginia	902,034	122,283	840,113	111,879	—7	—9
West Virginia	412,595	37,205	380,726	32,137	—8	—14
Wisconsin	5,665,797	1,726,333	6,126,143	2,120,669	+8	+23
Undistributed†	897,985	53,352	1,779,823	47,815	......	......
Total	34,781,238	4,876,445	38,492,881	5,498,269	+11	+13

*Included under "Undistributed."

†1921: Louisiana, Montana, Nevada, New Mexico, South Dakota, Washington, Wyoming; 1922: Louisiana, Montana, Nevada, New Hampshire, New Mexico, North Dakota, Vermont, Washington, and Wyoming.

SOFT DRINKS.

Mineral waters used in the manufacture of soft drinks in 1922

State	Number of springs		Total	Gallons
	Soft drinks only	Soft drinks and table or medicinal waters		
California		8	8	560,080
Colorado		3	3	87,000
Connecticut	3	5	8	341,131
Iowa	1	2	3	168,000
Maine	1	3	4	333,229
Massachusetts	3	5	8	1,106,822
Michigan		4	4	140,850
Minnesota		5	5	218,393
New York		5	5	74,891
Oregon		3	3	9,230
Pennsylvania	1	6	7	488,821
Rhode Island		3	3	118,000
Virginia		3	3	23,079
Wisconsin	5	11	16	777,693
Other States*	5	20	25	1,384,416
	19	86	105	5,831,635

***Alabama, Georgia, Illinois, Kansas, Kentucky, Louisiana, Maryland, Nebraska, and Wyoming; 1922: Louisiana, Montana, Nevada, New Hampshire, New Mexico, North Dakota, Vermont, Washington, and Wyoming.**

Value of medicinal and table waters sold in the United States in 1922.

State	Medicinal waters	Table waters	Total
Arkansas	$22,885	$5,981	$28,866
California	105,931	327,780	433,711
Colorado	3,345	51,938	55,283
Georgia	2,998	33,858	36,856
Indiana	137,671	18,687	156,358
Kansas	51,365	13,189	64,554
Maine	87,655	281,284	368,939
Maryland	----	73,890	73,890
Massachusetts	3,717	77,957	81,674
Mississippi	25,966	----	25,966
Missouri	31,760	8,389	40,149
New York	103,513	697,318	800,831
Ohio	8,371	154,443	162,814
Oklahoma	997	45,050	46,047
Pennsylvania	6,961	74,474	81,435
Rhode Island	----	25,704	25,704
South Dakota	----	32,850	32,850
Tennessee	15,525	52,313	67,838
Virginia	77,599	34,280	111,879
Wisconsin	9,985	2,110,684	2,120,669
Connecticut, New Hampshire, New Jersey, Vermont*	8,928	102,703	111,631
North Carolina, South Carolina*	23,909	7,654	31,563
Alabama, Florida*	13,624	44,556	58,180
Kentucky, West Virginia*	27,498	35,069	62,567
Louisiana, New Mexico, Texas*	51,453	17,550	69,003
Illinois, Iowa*	1,445	21,022	22,467
Michigan, Minnesota*	1,011	305,292	306,303
Montana, North Dakota, Washington*	5,378	8,004	13,382
Nevada, Oregon, Wyoming*	595	6,265	6,860
Total	830,085	4,668,184	5,498,269

*Combined according to locality to avoid disclosing confidential information.

CONDITION OF TRADE.

Mineral waters sold in the United States, 1918-1922

Year	Number of commercial springs			Gallons†	Value†	
	Total	Water used for soft drinks only	Water sold for table or medicinal use*		Total	Average (cents)
1918	569	16	553	40,709,722	$4,533,001	11.1
1919	527	26	501	38,697,280	4,880,186	12.6
1920	479	23	456	36,218,260	4,860,915	13.4
1921	456	22	434	34,781,238	4,876,445	14.0
1922	452	19	433	38,492,881	5,498,269	14.3

*Water from some of these springs is used also for soft drinks.
†Does not include water used for soft drinks.

The mineral-water business on the whole shows comparatively little change from year to year. The number of active springs tends to decrease, the quantity of water sold changes comparatively little, and the average value per gallon increases. These changes are likely to continue as more of the smaller producers find it unprofitable to continue in business. There is still a large field for the sale of bottled waters in cities where the water of the public supply is at times unpalatable. The sale of bottled mineral waters for medicinal use is not likely to increase greatly, but the building up of health and pleasure resorts around springs offers opportunities to those who have the necessary means, inclination, and experience.

MINERAL TRADE IN ALABAMA—1922.

In 1922 the mineral water trade in Alabama showed a great improvement over that of 1921. In 1921, 892 gallons were sold from four springs at a value of $690 or at the average price of 77 cents per gallon. In 1922, 5389 gallons were sold at the average price of 16 cents per gallon, a total value of $875. The increase in quantity sold during 1922 over that of 1921 was 504 per cent, and in value of 27 per cent.

The following list gives the name and location of each spring or well from which sales of water were reported for 1922 and of some whose waters were used only in the manufacture of

soft drinks. Most of the bathing and hotel accommodations noted are in establishments conducted by the owners of the springs, and the statements made are those given in the reports made by the owners. The list is far from complete as regards bathing establishments and hotels maintained in connection with mineral springs, because it includes only the names of springs from which water was sold or used for making soft drinks.

Springs or wells from which mineral waters were sold in 1922.

Spring or well	Location		Bathing establishment (B) and hotel (H), with capacity (number of guests)
	Nearest post office	County	
Coldwater Springs	Anniston	Calhoun	
Healing Springs	Healing Springs	Washington	H (70)
Matchless Mineral Wells	Greenville	Butler	
Shocco Springs	Talladega	Talladega	H (35)
White Sulphur Wells	Jackson	Clarke	B, H (100)

The following tables add some details to the general statements above given:

Mineral waters sold in Alabama in 1921 *and* 1922.

Year	Commercial Springs	Quantity sold (gallons)	Average price per gallon (cents)	Value of medicinal waters	Value of table waters	Total value
1921	4	892	77.2			$690
1922	5	5389	16.0	$815		875

Comparative production of mineral waters in Alabama in 1921 *and* 1922.

Year	Commercial springs	Quantity sold (gallons)	Value of product
1921	4	892	$690
1922	5	5389	875
Increase	1	4497	185
Percentage		504	27

A comparison of American and European mineral waters, by Alfred A. Chambers, is given in "Mineral Resources of the United States," Part 2, pages 500-508. A discussion of the waters of Alabama may be found in a report of the Geological Survey of Alabama, "Underground Waters of Alabama," by Eugene A. Smith, State Geologist, 1907.

MINERAL WATER PRODUCERS IN 1922

Gordon Mineral Springs, one-half mile west of Canoe, Escambia County.

Healing Springs, Healing Springs, Washington County.

Matchless Mineral Well, three miles southeast of Greenville, Butler County.

Shocco Springs, Talladega, Talladega County.

White Sulphur Wells, one mile southeast of Jackson, Clarke County.

Coldwater Springs, Anniston, Calhoun County.

SAND AND GRAVEL.

By L. M. Beach

THE production of sand and gravel in the State in 1922 was 848,743 short tons valued at $346,920 as compared with 774,616 short tons valued at $381,425 in 1921. An increase of 9.6 per cent in quantity, and a decrease in value of 9 per cent. The above figures do not include 63,423 tons of chert, valued at $20,209, produced in Alabama and used for road work.

The amount of sand increased from 233,187 tons in 1921 to 443,180 tons in 1922. An increase of 90 per cent. The increase in value was from $152,546 to $217,377 or 42.9 per cent.

There was a decrease in the production of gravel in 1922. The decrease was from 541,429 tons in 1921 to 405,563 tons in 1922. A decrease of 25 per cent. A decrease in value from $228,879 to $129,543 or 43 per cent.

Most of the sand produced during 1922 was for building, moulding and paving purposes. Only a small amount being used for other purposes. A considerable decrease in the amount of railroad ballast is noted for this year. A decrease from 386,766 tons to 230,974 or 67.3 per cent. Gravel for building and paving purposes showed an increase from 154,663 tons to 174,589 tons or an increase of 12.9 per cent.

The following tables give a comparison of the production of sand and gravel, and the kinds of sand and gravel produced for 1921 and 1922.

Production in short tons of sand and gravel in Alabama in 1921 *and* 1922

	Sand		Gravel		Total		Percentage of U. S. total
	Quantity	Value	Quantity	Value	Quantity	Value	
1921	233,187	$152,546	541,429	$228,879	774,616	$381,425	1.01
1922	443,180	217,377	405,563	129,543	848,743	346,920	0.89
Change	+ 209,993	+ 64,831	— 135,866	— 99,336	+ 74,127	— 34,505	......
Percentage	+ 90.0	+ 42.9	— 25.0	— 43.0	+ 9.6	— 9.05	......

Quantity (short tons), value and kind of sand produced in Alabama in 1921-1922

Year	Gravel		Moulding Sand		Building Sand		Paving Sand	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1921	154,663	$128,490	18,904	$16,743	205,984	$130,363	7,329	$4,840
1922	174,589	101,101	25,991	23,052	390,074	180,656	22,315	10,694
Increase or decrease 1922	+ 19,926	— 27,389	+ 7,087	+ 6,309	+ 184,090	+ 50,293	+ 14,986	+ 5,854
Percentage	+ 12.9	— 21.2	+ 37.4	37.7	+ 89.0	+ 38.4	+ 204.0	+ 121.0

Quantity (short tons), value and kind of sand produced in Alabama in 1921-1922—*Continued*

Year	Engine Sand		Grinding and Polishing Sand		Railroad Ballast Sand and Gravel		Total	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1921	1,000	$600	....	....	386,766	$100,389	774,616	$381,425
1922	*	*	*	*	230,974	28,442	848,743	346,920
Increase or decrease 1922	*	*	*	*	— 135,792	— 71,947	74,127	— 34,505
Percentage	*	*	*	*	— 67.3	— 71.5	+ 9.6	— 9.05

*The figures may not be given, as there were less than three operators.

Limestone for Building Purposes.

The preparation of cut stone for building purposes in Alabama, while on the increase, is not yet what it should be. practically all of this material comes from the quarries in the Subcarboniferous limestone of the Tennessee Valley, the most important quarries being at Rockwood, in Franklin County, operated by Foster and Creighton Co., of Nashville. This stone is quite similar in appearance, composition, and other qualities to the Indiana stone, and so far as experience in the use of the stone from the two localities in the buildings of the University of Alabama goes, the Alabama stone holds its own under influence of the weather better than does the Indiana stone. Stone steps, door sills, and window sills, buttress caps, etc., of the Alabama stone put in place in 1885 show practically no deterioration in color and wear under foot, and in crumbling and roughening under the influence of the weather, which cannot be said of some portions of the Indiana stone used in buildings erected in 1909-10. The Rockwood quarries have most modern and approved methods of machinery for sawing the stone and handling it in transit to the mills and elsewhere. The stone is of massive formation, of great thickness and extent. Blocks weighing as much as 25 tons, without crack or flaw, are not infrequently quarried, the size of the blocks being practically limited only by the capacity of the hoisting machinery. These quarries were taken over by the Government in July, 1918, and the output of building stone was greatly curtailed. It was the plan of the Government to operate these quarries in connection with the nitrate plants in that vicinity, the stone being of the desired quality and the supply practically unlimited. A considerable amount of new machinery was placed in the quarries and operations were begun on a large scale. The quarries were returned to the owners in March, 1919.

The Oolitic variety is most extensively used for building and monumental work. It is of light gray color, uniform grain, and homogeneous texture. It possesses the quality of cheapness, it can be cut to any design required, and it is at the same time strong and durable.

If adequate machinery for doing finishing work was installed at the quarry there would no longer be any reason

for going out of the State for this grade of stone. Already the material has been very extensively used in public buildings in Mississippi and Tennessee, as well as in Alabama. The only reason why it was not used in the recently erected buildings at the University of Alabama was that at the time these building contracts were let, the quarries furnished only the rough sawn stone and there was not in Alabama any establishment adequately equipped for the dressing of the stone in the quantity needed.

The above statements are confirmed by a report on the comparative tests made on the Rockwood stone, and those from Bedford, Ind., and Bowling Green, Ky., by Prof. Robert H. McNeilly, in the Engineering Laboratory of Vanderbilt University.

From this report we give the following extracts:

"*General Characteristics.*—The Rockwood limestone is an almost pure oolitic limestone with frequent small crystals of calcite distributed throughout its mass. It resembles closely the bedford stone in appearance, except that it has a slightly more open texture. The Bowling Green stone is finer in grain, softer and more easily pulverized than either the Bedford or Rockwood stones, and contains an appreciable amount of petroleum, which lends somewhat to the ease with which it is worked. In all three stones the texture is exceptionally uniform, as it is almost impossible to detect the bedding planes by eye; however in this respect the Bowling Green stone is most marked, and it is frequently necessary to test by hammer to detect which is the bed plane. Rockwood stone is lighter in color than either the Bedford or Bowling Green stones.

"*Chemical Analysis.*—The following is an analysis of the Rockwood stone made at my request by Dr. Paul C. Bowers, Chief Chemist of the Tennessee Geological Department:

	Rockwood Stone
Moisture and loss on heating to 175° C	0.07
Insolublue siliceous residue (SiO_2, etc.)	0.49
Oxide of Iron and Alumina (Fe_2O_3 & Al_2O_3)	0.30
Carbonate of Lime ($CaCo_3$)	98.23
Carbonate of magnesia ($MgCO_3$)	0.97
Total	100.06

"*Physical Tests.*—Comparative physical tests of the three samples of stone were made as follows:

Loss in weight on drying,
Cross bending tests,
Compression tests,
Absorption tests,
Per cent of water absorbed,
Specific gravity in bulk, and of pulverized stone,
Density,
Abrasion tests.

The result of these physical tests are summarized in the *Conclusions* below quoted:

"*Conclusions.*—The above tests were made as nearly as possible, under identical conditions, and barring the accidental characteristics of the samples, which were selected at random, these results are believed to represent truly the comparative characteristics of each of the stones under consideration.

"The Rockwood stone shows itself to be a superior building stone to others in every respect except density—but even here, since its absorption of water is the lowest of the three, it should prove more durable, while the smaller weight per cubic foot can be placed more cheaply on account of freight charges.

"As compared with the Bowling Green stone, the Rockwood shows a decidedly higher strength, and characteristics which indicate a greater durability. The Bowling Green stone, however, is undoubtedly more easily worked than either of the other two stones, due to its being softer and also the presence of oil. This oil has the bad effect of staining the stone itself and the contiguous masonry for several years after it is placed, while the very ease with which the stone can be worked makes the Bowling Green very inferior where used for door sills and steps. This is shown well by the Abrasion Test which shows the Rockwood stone in its best light, as a very superior material, for steps, door sills, and other places subject to wear.

"From my examination of these three stones, I believe no builder would make a mistake in using any one of the three, for they are all unquestionably very superior building stones. While each stone may have advantages over the other for some specially desired characteristics, as a building stone for general purposes, each is highly satisfactory.

Respectfully submitted,
ROBERT H. MCNEILLEY,
Assistant Professor of Civil Engineering, Vanderbilt University."

LIMESTONE PRODUCERS FOR 1922

Southern Roads Co., Birmingham, Ala.
Cheney Lime Co., Algood, Ala.
C. M. Noble, Anniston, Ala.
East Quarry Co., Glencoe, Ala.
The Alabama Co., Birmingham, Ala.
Woodstock Operating Corp., Anniston, Ala.
Foster & Creighton, 807 First National Bank Bldg., Nashville, Tenn.
Dolcito Quarry Co., Birmingham, Ala.
McDonough Ore & Mining Co., Birmingham, Ala.
Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.
Sloss-Sheffield Steel Co., Birmingham, Ala.
W. B. McCulloch, Albany, Ala.

MARBLE.

The marble of Alabama is of two kinds, crystalline, or true marble, and non-crystalline.

The crystalline or statuary marble occurs mainly in a narrow valley along the western border of the metamorphic area, extending from Marble Valley in Coosa County, through Talladega into Calhoun. The length of the marble belt through Coosa and Talladega counties is about fifty miles. The width of the valley carrying the marble as a rule is from one-quarter to one-half mile, widening in places to a mile and a quarter, for example in the neighborhood of Sylacauga.

The quarries longest known are Gantt's and Herd's near Sylacauga, Nix's near Sycamore, Bowie's near Rendalia, and Taylor's and McKenzie's near Taylor's Mill, east of Talladega. From all of these marble was quarried before the Civil War.

The plant of the Alabama Marble Company at Gantt's Quarry, which was completely destroyed by fire in December, 1910, has been rebuilt and equipped with all the machinery needed for the working up of any kind of finished product.

It is fairly safe to say that on the whole the marble from this quarry and immediate vicinity is of the highest grade of commercial white marble now on the market and obtainable in large quantity. There are small quantities of marble produced both in Italy and Vermont that are somewhat freer from coloring matter than the best grades that can be produced in Alabama in any quantity. But on the other hand, the poorest grades in Alabama greatly surpass the poorest grades produced elsewhere, so that the average of the Alabama deposit

is probably somewhat higher than that of any other so far developed, not excluding even the marble from the Carrara district in Italy. The marble from this State (Gantt's Quarry) has now a well established reputation and has been used in more than 200 important buildings throughout the United States. It can be seen in the galleries of the National Museum in Washington.

The Moretti-Harrah Company furnishes the marble in blocks for monumental and rough interior purposes.

A beautiful quality of variegated limestone or marble—red, pink and white—belonging probably to the Cambrian formation, occurs in Shelby County, a mile or two south of Shelby Springs station on the L. & N. railroad, and extending thence southwest for a mile or two. Nothing but prospecting work has been done on this marble. The Trenton limestone in the Appalachian valleys, particularly Jones Valley below Bessemer, contains marble similar to that quarried in the vicinity of Knoxville, Tenn. Also at Pratt's Ferry on the Cahaba river in Bibb County a quarry was for many years worked in this formation and turned out a very beautiful quality of marble varying in color from gray through pink, red and brown shades.

A black marble which is exceedingly promising, has been reported and some development work done near Anniston, and at Piedmont, Calhoun County, and some very handsome specimens of cave onyx have been obtained from near Kymulga in Talladega County.

In the Coastal Plain the St. Stephens limestone of the Tertiary holds ledges of hard, almost crystalline rock capable of taking good polish. The colors vary from nearly white, through shades of yellowish into red, and it would make a handsome decorative marble, especially for inside work.

Other limestone formations, such as the Subcarboniferous and the Knox Dolomite, could in places be drawn upon for marble.

MARBLE PRODUCERS IN 1922

The Alabama Marble Co., 916 Bell Bldg., Montgomery, Ala. Quarry in Talladega County, Alabama.

Moretti-Harrah Marble Co., Sylacauga, Ala. Quarry at Sylacauga, Talladega County, Alabama.

SANDSTONE.

In 1922 there was a slight increase in the value of sandstone produced in the State. The production for 1922 was valued at $41,395 as compared to $36,741 in 1921, an increase of 12.6 per cent. The greater amount of the standstone came from Jefferson, Calhoun and Cherokee Counties.

Value of sandstone and limestone production in Alabama, 1917-1922

Year	1917	1918	1919	1920	1021	1922
Limestone	$1,278,908	$1,370,667	$1,090,065	$1,925,704	$737,513	$787,040
Sandstone	17,098	14,484	33,852	61,604	36,741	41,395

SANDSTONE PRODUCERS IN 1922

Harbison-Walker Refractories Co., Pittsburgh, Pa. Quarry at Rock Run, Cherokee County, Alabama, and also in Calhoun County, Alabama.

U. S. Engineer's Office, Tuscaloosa, Ala. Quarry at Lock 12, Warrior River, Tuscaloosa County, Alabama.

J. Black & Sons, Jefferson County, Alabama.

Tennessee Coal, Iron & R. R. Co., Jefferson County, Alabama.

W. W. Brooks. Quarry in Morgan County, Alabama.

SUMMARY.

BECAUSE of the difference in the units of measurement employed in the various branches of the mineral industry, a summation of the production of the year can include only the values of the products. It is also to be noted that a simple summation of all the values of the minerals or mineral products listed in this pamphlet would give a value much in excess of the true value, since in many cases, as for instance coal and coke, and iron and pig iron and steel, the second product is directly a product of the first, and the value of the first is included in that of the second. To give the values of both as a part of the total would be to repeat, in a measure, at least a partial value of the first or raw product and would give an erroneous result.

As the Survey has not, however, the figures upon which to base an estimate of the percentage of each product which was used in the manufacture of some other product, the summation of the mineral production of the State as here given will be a simple summation of the values reached by the individual branches of the industry.

According to this rather unsatsifactory manner of summation which does not include the value of steel produced, the value of raw materials and immediate derived products in 1922 was $119,080,536, as compared with $93,353,444 in 1921, an increase of $25,727,092 or 27.5 per cent.

The production may be classified as follows:

Raw products	$ 53,575,597
Pig iron	42,883,424
Coke	14,708,245
Lime	979,331
Cement	4,135,684
Clay products	2,798,255
Total	$119,080,536

The more important minerals and products after pig iron, coal, and coke are iron ores, cement, clay products, lime, limestone, sand and gravel, given in the order of their relative importance.

Below is a tabular presentation of the value of the mineral products of Alabama, as estimated above for the years 1912, to 1922 inclusive:

Year	Value
1912	$ 60,141,793
1913	67,530,089
1914	56,769,559
1915	61,791,958
1916	94,987,229
1917	158,008,952
1918	189,426,896
1919	137,187,345
1920	197,699,592
1921	93,353,444
1922	119,080,536

123

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